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TREES AND FERNS.

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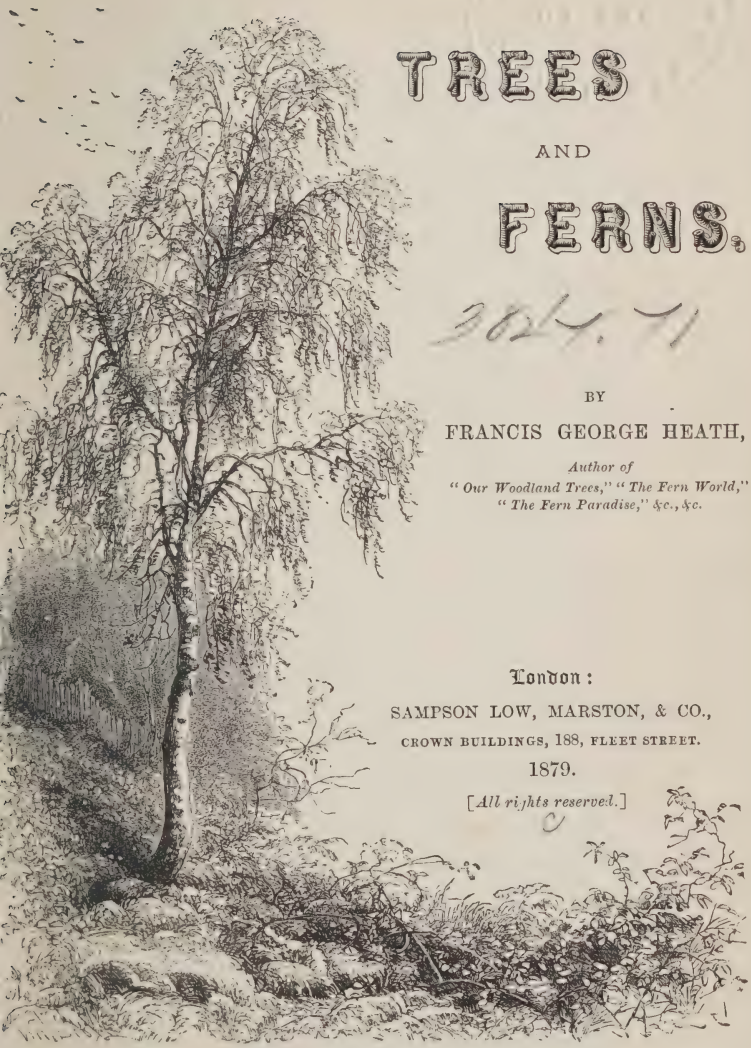
'Trees and Ferns.'

'Trees are always beautiful.'

Page 42.

Frontispiece.



TREES AND FERNS.

304. 71

BY

FRANCIS GEORGE HEATH,

Author of
"Our Woodland Trees," "The Fern World,"
"The Fern Paradise," &c., &c.

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1879.

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TO LOVERS OF TREES AND FERNS.

The success attending the publication of 'Our Woodland Trees,' of 'The Fern World,' and of 'The Fern Paradise,' has induced the Author to reprint some portions of the three books within the covers of the present little volume. 'Our Woodland Trees' is divided into four sections entitled respectively, 'The Life of a Tree,' 'Some Woodland Rambles,' 'Trees at Home,' and 'British Woodland Trees.' The first of these forms Part I. of 'Trees and Ferns.' In 'The Fern World' there are five principal parts or divisions, namely,—I. 'The Fern World,' II. 'Fern Culture,' III. 'Fern Hunting,' IV. 'Some Rambles through Fernland,' and V. 'British Ferns: their Description, Distribution, and Culture.' The sections entitled 'The Fern World' and 'Fern Hunting' are reprinted in Part II. of 'Trees and Ferns.' The chapter—in Part II. —'About soil for Ferns,' and that devoted to 'The Spleenworts' are reprinted from 'The Fern Paradise.'

The little volume therefore will give the reader seven chapters on Trees, discussing—after introduction—'The Tree Germ,' 'Early Growth,' 'Structure,' 'Development,' 'Perfection,' and 'Beauty;' and fourteen chapters on Ferns—an introductory one, eleven others on 'The Germs of Fern Life,' 'Conditions of Growth,' 'Structure,' 'Classification,' 'Distribution,' 'Uses,' and 'The Folk-lore of Ferns;' on 'Fern Hunting,' 'Fern Holidays,' 'Fern

Collecting,' and 'Frond Gathering;' one 'About Soil for Ferns,' and a concluding chapter on the 'Spleenworts,' giving descriptive sections relating to the Forked Spleenwort, the Alternate Spleenwort, the Rue-leaved Spleenwort, the Black Maidenhair Spleenwort, the Lanceolate Spleenwort, the Rock Spleenwort, the Green Spleenwort, the Common Maidenhair Spleenwort, the Sea Spleenwort, and the Scaly Spleenwort.

The Index at the end of the volume has been prepared in order to give a comprehensive view of the contents of these twenty-one chapters; and a glance at this index will prove—the Author hopes—that he has been enabled, within a small compass, to give a good deal of interesting information on two subjects which have not only a powerful attraction, but a fascination for a vast number of persons.

An especial object is, however, sought to be attained by the publication of this little book. While it is hoped that it will convey—in a manner that will give pleasure to the reader—some useful information relating to its subjects, it is at the same time intended to appeal to a sentiment—to inculcate, or to stimulate, where inducement is unnecessary, a love for the study of Trees and Ferns.

Powerful assistance in the promotion of this especial object will be afforded, the Author believes, by the landscape engravings—by eminent artists—which surmount the chapter headings. The artists whose drawings are there reproduced include Mr. W. H. J. Boot, Mr. Birket Foster, Mr. Harrison Weir, Mr. E. M. Wimperis, 'E. V. B.,' Mr. T. Creswick, Mr. T. Kennedy, and Mr. Julian Portch. The frontispiece, the engraving which appears on the title-page, and the fronds unrolling, surmounting the fourth

chapter of Part II., drawn by Mr. W. H. J. Boot, and engraved by Mr. J. D. Cooper, are from the charming *Edition de luxe* of 'Our Village,' and have been kindly lent by the proprietors of that delightful book for reproduction here.

Whilst the Author hopes that the price at which this little volume is produced will—by placing it within the reach of all classes—cause it to be widely read by those who have as yet given little or no attention to the delightful subjects of which it treats, he also ventures to hope that he may secure a large constituency of readers amongst the young. To inculcate a love of Nature amongst his children should be one of the first objects of a parent; for a taste for the delightful pursuits which, of necessity, will lead them into the lanes and woods, must have an incalculable influence for good. To induce this love of Nature, the subjects which it may be desired to teach children should be so handled as to arrest their attention and to chain their interest: and this could scarcely be done by putting before them the science of botany in its most unattractive and repellant form—a form which necessitates the preliminary acquisition of hard English words and of a host of Greek and Latin names. Care, too, must be taken not to confuse the child's mind by presenting to it, in the first instance, too great an assemblage even of the beautiful things in the natural world. But by leading the way into the woods, and pointing out the beauty and magnificence of Trees, and the fascinating gracefulness of Ferns, how easy it would be to fix the attention and arouse the interest; and, having once proceeded so far, to follow on from subject

to subject, unveiling new beauties and fresh sources of delight at every step! Though the chapters of which this volume consists were not written or intended for children, there is nothing in them, it is believed, that will prove hard to understand; and the Author therefore trusts that it may answer the double purpose which he has in view.

The sections relating to the charming little group of our British Spleenworts, have been selected for inclusion here, for the reason that they are amongst the most beautiful of our native Ferns, can be cultivated in the smallest possible space, and are more likely perhaps than some other groups of the beautiful class of cryptogamic plants to which they belong, to create enthusiasm for the further pursuit of the study of Ferns.

Hundreds of thousands of those who are continually 'running into the country'—sometimes for a stay perhaps of only a few hours—know nothing either of Trees or Ferns—that is to say of their structure and life, and of the beautiful forces which promote their growth, minister to their development, and conduce to their loveliness. If before starting on such excursions these wanderers afield will put this little volume into their pockets to read on their journey, the Author hopes that they will not be disappointed in its contents. He at least can assure them that he has striven *not* to be tedious; and his labour will be rewarded if the result be to instil but one spark of enthusiasm for the beauties of Nature into the hearts of its readers, and to create in them the desire to make further explorations in so delightful a field.

London, *May*, 1879.

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THE ILLUSTRATIONS.

The wood engravings enumerated below are from drawings by the eminent artists whose names are given opposite each indicated page.

The Frontispiece	Mr. W. H. J. Boot.
Title Page ('The Lady of the Woods') . .	Mr. W. H. J. Boot.
Page 1	Mr. E. M. Wimperis.
„ 13	Mr. Birket Foster.
„ 18	Mr. E. M. Wimperis.
„ 26	Mr. T. Kennedy.
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„ 58	Mr. W. H. J. Boot.
„ 70	Mr. Julian Portch.
„ 81	Mr. Harrison Weir.
„ 88	'E. V. B.'

TREES AND FERNS.

Part I.

TREES.

CHAPTER I.

INTRODUCTORY.

A TREE, to the thoughtful and loving student of Nature, suggests ideas of beauty and perfection to which the mind cannot be lifted, save by a process of wondering admiration. The minutest forms of vegetable life—forms which our unassisted eyes cannot even discern when the

most vigorous powers of vision are brought to bear upon them—open up, under the microscope, vast fields for inquiry and research; and, from these almost infinitesimal points of departure, there is a marvellous gradation, each stage of which represents a higher and higher state of progress towards completion—within the region of the vegetable kingdom—until is reached that which is the most wonderful and beautiful handiwork of the Creator, the absolute perfection of plant life—a Tree.

How minute are the starting-points—if we may so term them—of vegetable life, is scarcely comprehended by those who, through the engrossing claims of business or other occupation, may have had little time or opportunity for the study of Nature. What often appears to the naked eye on some dark object as the tiniest covering of dust, as some coloured film on a watery surface, or as the slightest of stains on wood or stone, reveals to us, when magnified, a little world of vegetable life, made up of countless numbers of individual plants, each one of which is possessed of a marvellous and beautiful organism, fitting it to live a separate existence; to develop, within its tiny sphere of growth, by the cohesion and co-operation of its atomic parts; and, finally, to provide for the perpetuation of its kind, ere its small life is given up, and it returns to the earth the elemental substances of which it is composed.

There are, indeed, few parts of the material world that are not instinct with the minutest forms of vegetable life, though oftentimes their presence can only be detected when they exist in vast numbers. The surface waters of the ocean are sometimes tinged with the most beautiful

colours by the presence of myriads of almost infinitesimal plant forms. Vegetable forms exist also in the ocean's depths. Even in the air, and in the very bowels of the earth, it has been asserted, by at least one eminent naturalist, that plants grow. Plants, too, are to be found on the surface of ice-bergs; tinging with roseate hue the snow of the arctic regions; covering the surfaces of arid plains; crowding into the lowest depths of mines; clinging, as powdery crusts, to rocks and stones; spreading, in varying colours—as moulds—over all kinds of objects; entering, with subtle and often fatal power, as blights, into leaves, stems, roots, and tubers; infecting, with a strength like that of an epidemic disease, the living organisms of animals; and, in short, penetrating everywhere, endowed with mysterious persistence and vitality, and sometimes, with a grasp on life which withstands degrees of heat and cold that are fatal to the majority of plants, and of plant germs.

If we turn from these, the most minute of the inhabitants of the great plant world, to the forms which, still minute, nevertheless come, individually, within the range of human vision, we shall but have reached another stage in the gradation of objects which lie within the realm of the vegetable kingdom. Looking around from this new stand-point we shall find ourselves in quite another world, with almost exhaustless material for wondering admiration—the world of moss and lichen, where Nature, with ten thousand forms of beauty, carpets the ground, flings her green mantle over wall, and rock, and Tree trunk, and clothes sea-shore and stream-bank with a verdant host of her tiny children.

One more stage upwards in the gradation of plant life. The forms which now engross our attention are small still; but they are of size sufficient to give us an indication of their presence—even were they deprived of other attractions—by the soft rustling sounds which they give forth when they are gently touched by the wind. Perhaps the careless man will see nothing to admire in a blade of grass. Yet is not the soul of the sincere lover of Nature moved with a pleasureable emotion when looking at the refreshing expanse of a rolling meadow, even when no bloom of colour occurs to relieve the uniformity of waving green? But rarely, during spring-tide and summer, do we wander anywhere without sight of at least one floral crown, if it be only a modest daisy, or the golden calice of a buttercup peeping out perhaps from the tiny strip of greensward which may front a city dwelling, or from the half-rural roadside of a town suburb; and if we pass beyond town limits we may see many a wide expanse of level meadow, gentle upland or hillside, bathed in a rich glow of colour from myriads of floral crowns—unbroken white, or gold, or purple.

Turning from the flowers which nestle amongst the blades of grass, and from the rustling green of these tender herbs, we shall pass, by another ascent in the scale of vegetation, through a gradation of varying beauty. Beauty, indeed, meets us everywhere. If from the empurpled hillsides, rising from our moorlands, we descend to the golden mazes of gorse in the plains below, and pass thence into the deep, soft shade of the woodland, we shall meet the graceful forms of clustering ferns, scent the sweet perfume of the honeysuckle, admire the glossy

green of trailing ivy around the small forms of modest shrubs, and thence by sweet gradation within the woodland shade, look higher and higher, until we have comprehended how much of beauty and grace, of vigour and stability, is embodied in the perfection of a Tree.

But this beauty and this grace—this vigour and this stability—qualities which place Trees in the order of excellence far above all other growths within the vegetable kingdom—are results which, in their full perfection, can never be manifested within less than the life of a generation, whilst oftentimes a period for the fulfilment of this beautiful purpose is required of longer duration than the life of many a nation. Yet the wise Giver of all good things has so beautifully adjusted the lives of Trees to the lives of men that no generation of men is born without finding the perfection of the Almighty's handiwork in the vegetable world. We know that in the beginning, before the creation of man, God said—'Let the Earth bring forth grass, the herb yielding seed, and the fruit-tree yielding fruit after his kind, whose seed is in itself, upon the Earth.' And we know also that in the omniscient order of things, 'the Earth brought forth grass and herb, yielding seed after his kind, and the tree yielding fruit whose seed was in itself, after his kind;' and that 'God saw that it was good.'

Though the period of time required for the full development and perfection of a Tree is so long, there is no stage of its growth during which it is not beautiful and useful to man; and though man, in the ordinary course of nature, cannot watch the rise and fall of an individual

amongst the noblest order of Trees—cannot, for instance, watch the rise and fall, if the fall be not premature, of an Oak—he will find that there is no stage of the Tree growth that he may not be able to study and admire.

CHAPTER II.

THE TREE GERM.

Nothing in Nature is more wonderful than the relation which exists between the most magnificent growths of the woodlands and the tiny seeds from which they take their origin. It is not owing to adventitious circumstances, due to isolated though persistent exercises of creative power, that the small seed in time becomes a mighty Tree. The vital principle of the Tree is embodied in the seed. The Almighty power has been exercised once in the endowment of the germ with its marvellous power of development. All else—all that follows—is but the setting in motion of an organization already possessed—possessed not indeed in the way which appeals most powerfully to the human eye—as in the expanded form of stem, leaf, and blossom—but in the minutest form of incipient life.

But this marvellous power, this setting in motion of the perfect and beautiful organization of the seed, is, in the Divine economy, and by the exercise of Divine wisdom, ordered only in its fit and proper season, and by the co-operation of other of the forces of Nature. Of these co-operating forces, and of the marvellous and beautiful results which they produce, we have not here to speak. Our immediate purpose is to explain—so far as explanation is possible—the position occupied by the seed when it has, in its perfected state, endowed with the vital principle of life by subjection to the mysterious process of fertilization, left the parent plant; but before it has—through the stimulation of its latent vitality by the active influence of external forces—been launched on its wonderful career of development.

The perfect seed, then, in its quiescent state, may be said to consist of two distinct parts—a vital part endowed with actual though latent life, and an inanimate part. The first part is the plantlet, or embryo plant. The dead part is that which ministers to the embryo by providing it with food and shelter. Each of these two principal constituents of a seed are again divisible into parts, though the parts have the same general character as the whole, and are either living or dead. The latter—the dead parts—to speak of them first, are the seed-coverings, cases, or envelopes—the houses or temporary abiding-places of the plantlets—and the secreted food of the latter. They are familiar to all persons, as envelopes, in the shell of the walnut and hazel-nut, and in the hard shining skin or case of the chestnut and acorn. The embryo coverings or *integuments*, as botanists technically

call them, are usually double. There is an outer integument called the *testa*, and an inner one called the *tegmen*.

How beautiful as well as useful are the outer integuments of the seed is shown in their form and colour. Sometimes they are beautifully white and glossy, at other times of a shining ebon black. Between these extremes there are varying shades of colour. The surface of the seed coat, too, is sometimes smooth and sometimes rough, sometimes plain and sometimes externally ornamented by beautiful markings.

Passing now to a consideration of the living germ or plantlet, we find that this consists of a little body made up of three principal parts—namely, the *radicle* or germ of the future root, the *plumule* or germ of the future stem —and all that rises above ground supported by the stem —and the *cotyledons*, or 'seed leaves,' as they are popularly and beautifully styled. Here it should be explained that the part last-named may in an individual plantlet be single or double—a cotyledon or cotyledons; and the distinction serves to divide into two groups all the flowering plants in the vegetable kingdom. Those whose seeds are furnished with but one cotyledon, or, if with more than one, having them placed in alternation on the embryo, are termed *Monocotyledons*. Those with cotyledons placed opposite in the seed, and in number consisting of two or more—the number is generally two—are termed *Dicotyledons*. It would be going beyond the scope of the present volume to discuss the distinction further, except to remark that these divisions of flowering plants—amongst which, of course, Trees are included—usually represent distinct kinds of structure and distinct methods of growth.

The size and form of the cotyledons in the dicotyledonous plants which include nearly all our woodland Trees are greatly varied. They are usually roundish bodies, are sometimes thick and fleshy, as in the acorn and in the Chestnut; sometimes thin, as in the Maple seed, and at other times crumpled or folded. Their purpose is to furnish—if we may borrow an expressive term from the science of mechanics—a sort of fulcrum to the plant in its earliest stage. Between the twin cotyledons is placed a small variously-shaped but usually cylindrical body consisting of two parts, united to each other end to end, the plumule and the radicle, which are, as we have seen, the one the germ of the future stem, the other the germ of the future root. The root end, destined to grow downwards and develop into the perfect root, is conical in shape. The opposite end, destined to grow upwards and develop into stem, branches, and leaves, is blunter; and this distinction, in the incipient forms of the root end and the stem end of the *axis*—as this double germ of the plantlet is, from its central position, called—very nicely foreshadows the qualities of stability and penetration finally established in the future stem and in the future root.

The surface of the integuments, or coverings of the vital parts of the plantlet, is pierced by a tiny aperture called the *micropyle*—a term derived from two Greek words, which mean a 'small mouth.' This aperture is the opening through which the mysterious process of fertilization has been performed by the pollen of the fertilizing organ; and it is to be especially noticed that the conical-shaped radicle of the axis of the embryo is almost invariably found so placed as to point to the micropyle.

But Nature is not content to make her enveloped seeds perfect in every part. She endows them with some quality which shall enable them, when freed from the parent plant, to find their proper sphere of growth. Sometimes she temptingly baits them with luscious edible coverings, which may tempt birds or animals to disperse them; and sometimes she provides them with wings that they may themselves take flight, and find fit resting-places, as in the downy hairs of the seeds of Willows and in the membranous wings of Pine seeds. More than a century before the commencement of the Christian era Theocritus wrote, 'Sweet is the murmur of the wind among the Pine-trees;' and how beautiful is the reflection that oftentimes in the mellow seeding-time the aërial currents bear away lovingly, on the sweet crest of a musical swell, the winged germs of a future generation of Trees!

There is yet one more consideration anent the perfected Tree germs. In what degree has Nature endowed these germs with the principle of vitality? How long can they resist the operation of decay—a process which dissolves the cohesion and prevents the co-operation of the mysterious forces which conduce to growth? These are deeply interesting questions. But we cannot answer them satisfactorily, and can only furnish a partial reply by a reference to a few known and isolated facts. These lead us to the conclusion that the vitality of seeds is extremely variable—in some cases being of short duration, in others extending over marvellous periods of time, when circumstances have prevented the operation of the process of germination. Instances of seeds which have ger-

minated after having lain dormant for more than a century have been authenticated, and there is presumptive evidence of the germination of seeds which have been disentangled from geologic strata. Even if we alone accept the recorded instances of germination suspended over the long period of a hundred years, can we do otherwise than marvel at the persistent vitality thus displayed?

CHAPTER III.

EARLY GROWTH.

How perfect and beautiful is the provision made by Nature, within the small envelope of a little seed, for the setting in motion of the complex and marvellous system which is destined to produce the future Tree we have seen in the preceding chapter. We have seen that within the shelly or other integuments, often fashioned with singular beauty, of the Tree germ there is latent vitality; but we have said nothing of the active life of the germ. We have touched only upon the preparations made for the commencement of that life, merely discussing the position of the seed in its dormant condition, and noticing for how long a period this dormant condition may be continued—over what a great extent of time—as man is accustomed to measure time—the concentrated energy and power of growth may be suspended through

the absence of that sympathetic touch which Nature, in her gentle moods, impresses upon the plant world.

Spring, in our native woodlands, is the season of early growth; and there is something very beautiful in the gentle awakening of flowers, shrubs, and Trees, after their winter sleep. We have not here, as in the tropical world, the charm of perpetual spring and summer. The genial rain and warmth of the one, and the resplendent glory of the other, are followed by the falling of the leaf, and by the icy chill of winter, when slumber falls on all, save a few of our native plants. The change brings cheerlessness to our woods and fields; but it prepares us for the joyousness of the succeeding spring, to which it helps to impart a pleasure that we should never know but for the intervention of the dormant season.

Throughout this dormant season the seed, ripened after the fall of the summer flower which bore it, sleeps like the plants themselves. The wintry rains supply one condition of growth, but the frosty temperature is uncongenial to germination. It is only when the influence of spring—the season of gentle warmth and genial showers—is exercised upon the plant germ, that it enters upon its career of development. It is many days before we see the gentle uprising of the budding plant: for in the darkness of its subterranean resting-place the seed has given full employment to the mysterious forces of Nature; and there has been much to do in order to commence the release of the enfolded embryo, to burst its integuments, and to bring the ascending portion of its axis—the plumule—to air and sunlight, to kindly dews and softly moistening rain, at the surface of the ground.

But almost simultaneously with—though generally before—the upward growth of the plumule the radicle has commenced a downward course, passing through the micropyle, and beginning the strain upon the integuments, which, taken in conjunction with the continuous expansion of the embryo, succeeds in first bursting and finally throwing them off. The seed-like form of the plant germ is now no longer apparent. We have the plantlet—immature and undefined as yet—but freed from its enveloping shroud: the joined plumule and radicle fixed—like a swimmer supported by corks—between the twin cotyledons.

And now, for a brief space, these small, but well-nourished bodies, perform the kind and useful office of nurses to the incipient stem and root. We shall see anon how the last-named organs, when they have reached a certain stage of their early growth, begin to provide themselves—by the aid of some very simple but very beautiful organs—with their natural food. Meanwhile their earliest supplies of the nourishment necessary to qualify them for self-support are provided by the cotyledons. The elongation of the radicle and of the plumule, is, however, continued but a short distance before these organs commence their self-supplying functions.

The radicle becoming, by enlargement and elongation, a root, the latter commences to multiply itself by giving off branches which, being usually more slender than the body from which they proceed, are called root fibres. It is these fibres, or rootlets, which penetrate the ground by insinuating their extreme points into the earthy interstices, displacing, by expansion, sufficient earth to provide

room for themselves. The collecting apparatus, however, for gathering what nourishment the plantlet requires from the soil, is supplied, not immediately by the root or root fibres, but by a beautiful series of delicate root hairs, These grow out from both the main root and the rootlets in large numbers, and being long, tubular bodies, though very minute, they absorb moisture from the surrounding earth by means of that, as yet unexplained, force—capillary attraction. The moisture thus extracted from the earth holds in solution those chemical substances which—by a beautiful and marvellous process of assimilation—minister to the growth of the embryo plant, and promote its stability.

The plumule, meanwhile, has been forcing its way to the surface of the ground, there to unfold a couple of tiny incipient leaves. In some plants the ascending plumule carries the cotyledons to the surface, where they unfold, and spread out their surface to the light, under the influence of which, by a process which will be subsequently explained, they change their colourless appearance to green, and fulfil for the plant in this, its early stage of growth, the same offices as are, at a later period, discharged by the leaves of the more advanced after-growth.

A stem has now been formed by the prolongation of the plumule: and the unfolding of successive leaves, as this stem continues its progress upwards, powerfully aids the growth of the young plant; for the leaves, as we shall subsequently see, obtain from the atmosphere a large proportion of that which constitutes the bulk of the plant's substance.

It is, of course, assumed that the beautiful process which has been described, continues its operation only under the continued influence of the conditions which occasioned its commencement—conditions which are naturally brought to the mind by the mention of the word 'Spring,' so suggestive as that word is of soft rain and gentle warmth. The temporary absence of sufficient warmth would check the young growth, which would, however, be resumed on the resumption of the necessary condition; but the entire absence of moisture, through the aridity of the soil, would be fatal in its effect, because the root hairs would cease to perform their functions, and the plantlet would shrivel and die.

At this stage of our history of the progress of growth in the Tree germ, we must pause for some explanation as to the nature of the substances of which the vegetable organs to which we have referred are composed.

CHAPTER IV.

STRUCTURE.

THERE is so much stability and permanence in the qualities which distinguish Trees from other and more fragile kinds of vegetation, that especial interest must attach to inquiries concerning their structure. The whole subject relating to the structure of plants is indeed exceedingly interesting to the student of Nature. But perhaps for the general reader, as that expression is usually understood, herbaceous plants—plants, we mean in this sense, that die down to their roots each year—have not quite the attraction which strongly induces investigation concerning the chemical substances of which they are formed. Such plants, from the circumstance that they disappear from sight and generally from mind during the dead

season of winter, are chiefly valued for their beauty or fragrance during spring, summer, or autumn. With the departure of their delicate tints and gorgeous colours, of their vernal freshness and sweet perfumes, they pass from the memory. But Trees are ever with us. When the budding beauty of spring, the full glory of summer, and the mellow charm of autumnal colouring have all departed, the Tree forms are still with us, and we can enjoy and admire the noble breadth of their trunks, the beautiful proportions of their limbs, and the delicate tracery of their filmy branches, bare, it is true, of their charming tresses of glorious leaves, but full of a grace and beauty which appeal powerfully not merely to the eye of the artist, but to the soul of the lover of Nature.

An elaborate description of the chemical properties of plants would alone require the space of a bulky volume—a considerable portion of which would be occupied by discussions concerning the yet unexplained mysteries of plant life and plant growth. Here we shall only attempt to state some of the principal facts which science has been able to establish—giving indeed so much as will naturally fall within the proportionate space which must be allotted to this part of the subject; yet enough, we trust, to satisfy all who have fairly comprehended the aim and object, and the necessarily limited space of this volume.

Plants, like ourselves, are composed of substances which are drawn by absorption and inspiration from the material world. Like ourselves they may be said to drink and to breathe—some even to eat. Like ourselves, too, the matters absorbed and inhaled into their system

are assimilated by them for the purpose of supplying the waste and contributing to the growth of their bodies. Unlike ourselves, however, their ordinary processes of growth—after the termination of the early growth which we call germination—are unattended by the production of heat which is not common to the earth or air or water in which their parts exist. They are indeed of the same temperature as the material substances which surround them and in which they grow, for the reason that such temperature is communicated to them from surrounding objects by the natural process of conduction.

We have already seen that the principal sources of the food of plants are air and water; and it is from these apparently simple substances that they obtain what they need to build up and consolidate their marvellous and beautiful structures. Water and air are words which convey very indefinite meanings except to the students of natural science. Water itself—by which we mean pure water, a substance which can only be obtained by distillation—is a chemical compound of hydrogen and oxygen gas. But natural water, as the term is popularly understood—water such as is found in the earth—is never pure, for the reason that it holds in solution—that is to say, in a liquid form, mixed but not chemically combined with the elemental particles of which pure water consists—certain chemical substances varying with varying circumstances both in quantity and quality. These substances often include calcium, iron, nitrogen, phosphorus, potash, soda, and sulphur; and it is from these, absorbed by the plant, that it manufactures by the further aid of the hydrogen and oxygen of which the

water is itself composed, and of carbon obtained chiefly from the air, that which constitutes its own substance. We may call these various substances the raw materials used by the plant in its process of manufacture, and it obtains them all either in a liquid or a gaseous state, transmuting them into solids for the purposes of its own solid structure. We have seen that the substances in the earth upon which the plant feeds are all—in a liquid form—absorbed by the root hairs exercising the power of capillary attraction, and conveyed into the plant by the exercise of the same power of attraction, which continues until the liquid matters have reached their proper destination.

But to enable the plant to assimilate the various matters which it derives from the soil and from the air, there must necessarily be a pre-existing structure; and by microscopical examination and the aid of the science of chemistry, we are enabled to ascertain the form of this structure and the nature and quality of the substance of which it is composed. The germ, for instance—the embryo of the future plant—enclosed in its small envelope is, we find, built up of a system of minute cells or cavities. There is, even in the minutest plant germ, a vast number of these cavities, and they are all constructed with marvellous and beautiful regularity. Nothing perhaps could better illustrate the beauty and symmetry of the form and arrangement of these cells than the familiar example of a honeycomb. But there is this difference. Instead of the aggregate of cells in the plant germ forming a rude and shapeless mass, they all contribute to the formation of objects of exquisite beauty, the variation of

external form in which is almost endless, being co-extensive with the varied and multitudinous forms of plants in the vegetable kingdom. The framework then—if we may so term it—of the plant germ consists of a series of walls investing an innumerable number of cells, or little chambers, packed closely together after the manner—though the shape of the cavities is different—of the cavities in the honey-comb, invested by their framework of wax. The cells in the plant germ are filled with a viscous or semi-fluid matter called *protoplasm*. The investing walls are formed of a substance called *cellulose*, intermixed with a watery fluid absorbed into the plant by the medium of its roots.

An embryo plant, then, consists of a system of cells and their contents; and the convenient expression *tissue* is used to imply the entire substance of which it is composed. There are differing kinds of tissue. *Cellular* tissue, as its name implies, consists of little cells or bags—which are mostly roundish or oval, in shape—and their enclosing protoplasm. It makes up the softer parts and forms the major portion of the substance of most plants. It indeed is very much the same to the plant as the flesh is to an animal body. *Wood* tissue consists of tubes or cells longer one way than another. These cells form, lying together and compressed, what we call wood. The walls of this kind of tissue become thickened as the plant grows; and it is by the thickening process that the qualities of hardness and firmness which we distinguish in wood are originated. *Vascular* tissue consists also of elongated cells or tubes. But the walls of these are thinner than those in wood tissue, and they enclose long

vessels, or *spiral threads* as they are called. The walls which enclose and make the cavities which are called cells—whether the latter are roundish as in cellular tissue, or oblong as in the tubes of wood or vascular tissue—consist, as we have seen, of a substance called cellulose, a substance compounded of carbon, hydrogen, and oxygen. The enclosing mass of protoplasm, or the viscid material which forms the cell contents, consists of carbon, hydrogen, nitrogen, and oxygen.

The green colour which gives so much of their beauty to plants, is caused by the presence within the superficial cells of their tissue of minute granules of a matter called *chlorophyll*. These granules exist in great abundance, and can be seen so clearly through the thin transparent surface walls of the superficial cells that they give their familiar hue to all the green parts of a plant. The beauty of colour, too, in the bloom of plants is caused by the presence of other granules of colouring matter—granules which owing to their varied distribution throughout the flower petal and the varying manner in which they are affected by chemical influences, including the varying effects of the influence of light upon them, impress us with that exquisite sense of colour which lends so great a charm to flowers. So far as science has yet been able to comprehend this subject—for there is very much which still remains undiscovered and undetermined—it has been found that there are not less than seven substances of the nature of chlorophyll existing in differing plants; that these substances have distinct colouring capacities, and produce by commixture in varying proportions the exquisite shades and variations of colour in the plant

world. It will therefore be desirable, as the word chlorophyll has generally been used to distinguish only that substance which gives to plants their green hue, to use the word *chromophyll* as one expressive in a general way of vegetable colouring matters; for we erroneously refer to the colour green, many plants whose leaves are much more than green. There is, for instance, a tinge of blue in many a leaf, there is gold in the foliage of Limes, and gold in the leaves of the graceful Beech. Purple and crimson too, and other hues and colours, are found oftentimes delicately mixed with the green of our leaves; and though the pervading greenness is often so conspicuous that it is difficult to detect the presence of any other colour, much of our sense of enjoyment, occasioned by the contemplation of 'lush greenery,' doubtless arises from the beautiful though almost imperceptible intermixture of other and lighter or darker shades. The gloss on the leaves of many plants is due to the extreme transparency and reflecting power of the surface walls of the superficial cells.

The embryo plant, then, consists of a beautiful cellular framework enclosing a protoplasmic fluid—the part underground being, from the absence of the chemical influence of light, devoid of colour; the part above ground being by the chemical action of sunlight displayed in hues equalling in richness and exceeding in number, by intermixture of shades, those of the rainbow. We have seen what is the structure and function of the rootlets and roots, stem and leaves. They are all cellular tissue modified by circumstances, and, by Divine wisdom, cast into an infinite variety of forms. We have seen how the

roots absorb nutriment from the soil, and what organs act as the means of communication. It remains to be shown that the means by which the leaves absorb their gaseous food from the atmosphere, are those provided by the existence of minute orifices in the leafy surfaces—chiefly on the under surface of the leaves. These orifices —called *stomata*—are oval in shape, and are very abundant; so much so indeed, that in a single leaf of some Trees—the Apple will furnish a familiar example—there have been counted more than a hundred thousand! Through their stomata, or breathing pores, plants not only absorb air, but give out their surplus moisture; and thus by the superabundance of the liquid which they derive by their roots from the earth, they are enabled to promote, around the tender forms of their leaves, the congenial moisture which is so conducive to healthy life and to vigorous growth.

CHAPTER V.

DEVELOPMENT.

From the embryo plant to the perfected Tree the successive stages of growth are accomplished in varying degrees of rapidity. The causes which promote a more rapid rate of growth in some species of plants than in others are amongst the mysterious facts relating to the development of vegetable life. We can, more easily, ascertain the reasons for the difference in the rate of progress in different individuals of the same species; for they mostly arise from differing degrees of vigour, or from more or less favourable conditions of growth. But if we subject two young Trees of different species, each being the most vigorous individual which can be selected of its kind, to two sets of conditions of growth, each of which is the most favourable—in the matter of soil, moisture, and aspect—to the individual species, we shall find, in general, a wide divergence in the rate of growth. There is an equally wide divergence in the habits of plants between

the various species. Trees, for instance, are distinguished from each other by the characters either of their trunks, of their limbs, of their leaves, or of their spreading, or other manner of growth. Without venturing to look for any explanation of the difference in the habits of different plants, to the theory—relating to the origin of species—propounded by an eminent naturalist, we may be assured that, whatever causes have occasioned the infinite variations in the forms of life in the natural world, these variations have been planned and accomplished by the beneficent Creator in order to promote the greatest happiness of mankind.

The method of cell division and multiplication is amongst the most interesting of the processes connected with the development of plant-life, the history of which will here be briefly traced from that period of its early growth at which the plumule of the embryo, after just emerging from its seed-cover, has reached the surface of the ground, and has there unfolded its twin incipient leaves. The cells of the cell-system of which, as we have explained, the embryo plant is formed, are at first very minute, consistently with the wise and beautiful economy of space observed throughout the natural world. Everything, indeed, in the delicate structure of the incipient plant is moulded on the smallest possible scale, for the reason that the means of necessary growth are provided in the elemental substances existing in the earth. The walls of the early cells are very thin, and the cell cavities are full of the protoplasmic matter which is—if the expression may be used—the life-blood of the plant. In the centre of each cellular mass of protoplasmic fluid

surrounded by its investing walls of cellulose, there may be observed a rounded substance, darker than the general mass—the word 'mass' is used as a convenient expression, although it will be understood that it refers to a minute portion of matter. This darker substance is, in reality, merely a portion of the protoplasm; but it is distinguished from the other portions by being designated the *nucleus*. Growth in the young cell commences by the enlargement of the cell walls. The protoplasmic contents not growing at the same proportionate rate, holes or cavities are left in their substance, and these cavities are filled with a watery liquid, which constitutes what is called cell-sap. The cell walls continue to be lined with layers of protoplasm; but it is believed that, by the nucleus separating into halves, the same kind of division is effected by a half of the surrounding protoplasm collecting round each portion of the divided nucleus. Between these separated portions of the original nucleus a wall of cellulose begins to form, and, when its formation is completed, it will be seen that the original single cell has become two.

By the repetition of this process of cell division the growth of young cellular tissue is effected, and the plant increases in size. The rate of increase varies with the varying nature, in different plants, of the power of growth; in some cases being marvellously rapid, in others much slower. When the cells have ceased to divide, they begin within themselves—each within each—a process of development—a process, in some cases, shown by a continued secretion of cellulose by the protoplasm ending in a considerable thickening of the cell walls; in other cases

by the manufacture from the protoplasmic fluid of various substances, which, in the wise economy of Nature, minister to the necessities and enjoyments of man.

How beautiful, indeed, yet how wonderfully mysterious is the influence of this power of development in plants! There is sweet co-operation between air, earth, and sunshine in order not only to perfect the beauty, but to promote the usefulness of plant forms; for from the simple elemental materials which have been already enumerated are formed in the cells, various substances, including chromophyll, oil, resin, starch, sugar, and wax.

The development of a Tree naturally presents itself to us as being of six different kinds. There is development of the root, of the stem, of the branches, of the leaves, of the flower, and of the fruit or seed.

Beginning with the root, we have seen that its incipient form consists of an elongation of the radicle of the embryo. Development takes place by continued elongation and branching, the branches being at first very thin and minute.

As we know that a certain density of the soil is essential to healthy plant life, we arrive at the conclusion that the conditions most favourable to root growth are those in which the embryo plant is surrounded by particles of earth having just sufficient porousness to admit a certain amount of air, and to permit the percolation of water. The root fibres, or filaments, which are at first the most delicate of threads, are pushed out by the power of growth from the root-stock or radicle of the plantlet, and insinuate themselves into the tiniest of the surrounding earthy interstices. Receiving nourishment from the

damp soil through the medium of the root hairs—long, hollow cells, which absorb moisture by capillary attraction—they rapidly become enlarged, and displace the soil around them. They then, in turn, give origin to other branches, which, in like manner, elongate, increase in size, and ramify. This process continuing, there is formed, with greater or less rapidity, according to the species of plant, and its power of growth, an extensive ramification; until, in the case of a full-grown Tree, we have a network of roots extending oftentimes, both vertically and horizontally, to a considerable distance from the bole of the stem, the primary, or first formed root-branches, frequently acquiring an enormous size, and making an appearance when, as is often the case, they are seen above the surface of the ground, like large branches of the trunk. From these enormous root-branches there is a regular gradation downwards in size, the ultimate filaments being amongst the most minute of threads. The upheaving power of the roots of large Trees is enormous; for, as the roots grow in size, they become hardened by the transformation of their soft tissue into the thickened and consolidated tissue which we call wood; and these woody roots, swelling as the Tree developes, exercise so much force that they have often been known to destroy buildings by displacing the stonework of their basements.

Meanwhile, during this process of root development the marvellous power of growth has been manifested above ground. The plumule has been elongating from its root pedestal into the stem, which is the mainstay of the plant—the column which is to support its system of

branches, leaves, flowers, and fruit. The formation of the stem in flowering plants gives occasion for their division throughout the vegetable kingdom into two great classes, called respectively, *Exogens* and *Endogens*, terms suggested by the facts that whilst the first-named class comprises plants whose growth is effected by additions to the stem or trunk outwards, *Endogens* increase by internal growth. The tissues of *Exogens*, too, are arranged upon a different plan from those of *Endogens*. The differing modes of growth and of the formation of the stem chiefly distinguishing *Exogens* from *Endogens*, we need not give in elaborate detail. All our forest Trees being exogenous—that is, growing by development of their stems outwards, we shall here discuss only that method of growth.

We ordinarily express the growth of Trees as we express the growth of man, reckoning its extent or duration by years. Our growth, however, is mostly persistent; that is to say, we grow continuously, with little regard to seasons, until we have reached our maximum state of development. But Trees are affected by the seasons, their period of growth being mostly confined to spring and summer, and rarely extending beyond the autumn. Amongst our deciduous Trees, or those whose leaves disappear in the autumn, or when touched by the first chills of winter, growth is suspended during the cold season. Hence, it is found that the additions to bulk during the annual periods of growth, observe a certain distinctness, and are shown in the stem—when cut across—by distinctive rings in the wood, each ring representing one year's growth. These ring-like appear-

ances, or concentric cylinders of wood are formed by additions outwardly to the woody substance of the Tree, the innermost ring representing the first year's growth; the succeeding rings of wood outwards representing the growths of succeeding years. By these interesting marks the age of a Tree can be ascertained—only, however, after it has been cut down, or some part of its trunk has been cut across.

If we take a completed first stage of the growth of a Tree—we may select for the purpose, as being one of the most familiar, both to town and country people, the Lime, and a stem of the age of one completed year will suffice for illustration—we shall find that the stem is built up of tissue in the following manner. There is a central column of cellular tissue, forming what is called the pith. Over this is a layer of wood tissue, mixed with a portion of vascular tissue. Next is a layer of *bast* tissue, or incipient inner bark. Then a layer of cellular tissue, or incipient outer bark. But running through the inner cylinders of tissue from the inner column or pith to the outer cylinder or bark are thin rays of cellular tissue. The direction taken by these rays or lines of cellular tissue may be indicated by comparing them to the spokes of a wheel. The method of growth of the substance of the stem after the first year consists in an addition of wood tissue *outside* the first cylinder of wood tissue, and between it and the first formed bast tissue. The bast tissue is renewed by a new formation of that kind of tissue *inside* the old bast tissue—this last-named process of tissue formation being in the reverse order of that which contributes to the formation of wood; and it will

be seen by this simple and beautiful arrangement that, whilst the method of exogenous growth of the wood tissue is adapted to the permanent consolidation of the woody or solid substance of a Tree, the formation of the newest coats of incipient bark—or *liber*—inside the earlier formed, or older bark, admits of the peeling off of the latter to make room for the increased circumference of the stem.

The formation of the buds which give origin on the stem of a Tree to its branches is a curious and interesting study, and is not by any means one of the least mysterious of the facts connected with the power of growth. By what marvellous influence is it that, at certain portions of the stem, at positions which are never fixed by unvarying rules, and which constantly vary not only in plants of different species but in different individuals of the same species, there is a bursting forth of life—a budding into greenness—accompanied by the power—truly it is to us a mysterious power—to reproduce everything that has been produced before in the same plant—stems, branches of these, foliage and fruit? All that can be explained of the branch is that it is a continuation of the stem on which it grows, with continuation of the stem-tissues, pith, wood, and bark, both inner and outer bark, moulded in varying forms and with varying degrees of grace and symmetry, but always with beauty—for whatever the Tree, there is always delightful gradation rom trunk to branch, from branch to twig, from twig to tiniest spray. Nature has beautiful, though varying, means by which to protect the tender bud from injury by cold or wet—biting frost or excessive damp. She

covers it sometimes with gum, sometimes with hairs or scales, and sometimes with softest silk.

From the twigs or sprays of the spreading branch it is an easy transition to the leaves—the green gems which add so great a charm to the branching forms which they clothe. As the twig is a continuation of the branch in the same way that the latter is a continuation of the stem or trunk, so the leaf is a continuation, but a continuation with expansion, of the tissues of the twig. The framework of the leaf—its veins or nerves, which spread out like a network—consists of fibro-vascular bundles as they are termed, that is to say, of tissues formed by a commingling of wood, bast, and vascular tissues. The softer supervening portion of the leaf, that which is spread out like a garment over the fibro-vascular framework, is made up of cellular tissue. The forms of these beautiful expansions of the tissues of plant stems are in number infinite as the infinite variations in the loveliness of Nature. Their purpose is to afford the largest possible surface for the beneficial and beautiful operations of air and sunshine.

Air and sunshine, indeed, are so largely concerned in the development of Trees as to contribute, by the elements of the one and the influence of the other, no less than one-half of the substance which makes up their solid bulk. Carbonic acid gas—a combination of carbon and oxygen, largely contributed by respiration from animal lungs—is diffused throughout the atmosphere. Leaves, through their breathing pores, inspire this gas; appropriate for purposes of development and growth the carbon of the compound, and return the life-giving

oxygen to the air to add to the healthfulness of their surroundings. The glorious sunshine, which adds its golden hue to foliage, contributes its action—action mysterious though beautiful—to stimulate the process; so that there is co-operation in this marvellous work of usefulness between two of the most beautiful of the forces of Nature.

At a certain stage of growth—varying in different species of Trees and in different individuals of the same species—commences the production of the flower and the formation of the seed which is to follow the foretelling bloom. The blossoming of a Tree is not, as in so many other plants, the precursor of decline and decay; nor is this period of its life the sign of perfection; for development continues long after the 'first fair blossoming.' It is but the beginning of perfection; and of all the processes of Nature there is none more beautiful than the flowering of a Tree. Yet wonder must always be mixed with admiration when we think of the operations of Nature. Who can define or determine the causes which lead to the production of a flower? What influence is it that accelerates or retards the period of that production? Why is it that sometimes whilst all the necessary conditions of inflorescence appear to be present there is no blossoming, or blossoming is inexplicably delayed, or is curiously intermittent? What is it that determines the place—subject to so many unexplainable changes—at which the blossoming shall occur? And lastly—and this indeed comprehends the whole question—what is the mysterious influence which, at a certain period of the plant's history, causes the bringing

to one or to ten thousand parts of its surface of the sweetest forces of Nature—forces which contribute to the formation of the floral stem, of its green sepals, of its richly coloured or sweetly scented petals, of its stamens —with their mysterious anther-borne pollen—and, within the floral envelope, of the incipient ovule encased in its curious cover, and destined, after the mysterious process of fructification, to become the seed—that is to say, the embryo of the future Tree, with all its suggestiveness of strength and of beauty?

CHAPTER VI.

PERFECTION.

There is something which inspires the lover of Nature with an inexpressible feeling of awe in the contemplation of the perfect form of a noble Tree. Yet it is by the gentlest of natural influences—influences so gentle, and oftentimes so slow in their operation, as to be imperceptible after any other than long periods of time—that such gigantic strength and such amazing stability have been built up and established, as we see embodied in many even of our woodland Trees. From the tender stage of its first completed year, when the stem contained, besides its pith, its incipient first cylinder of wood, its liber or inner bark, and its outer bark, with its beautifully-arranged radiation of cellular tissue from centre to circumference, there has been continual increase, chiefly shown, as years have rolled on, in the woody consolidation of the trunk. The early office, and indeed the chief use, of the pith, have consisted in ministering only to the early

growth of the Tree. Through this column of tender succulent tissue the moisture absorbed by the rootlets has been first carried, passing from cell-wall to cell-wall, and contributing, by its wonderful changes, to the formation of wood and bark and leaf. Then, with the formation of the first year's cylinder of wood, the *alburnum* or *sap-wood*, as this cylinder when young and soft is first called, itself acts as the chief medium for the conveyance of the sap from root to stem, branches, and leaves—the *medullary rays*, or radiating strips of cellular tissue, acting, in a measure, as the branch canals for the more even and perfect distribution of the sap. As woody layer is thus laid upon woody layer—each alburnum cylinder fulfilling in turn the office of nurse before becoming hardened into wood—there is consolidation of the substance of the Tree as new sap-wood each year adds to its circumference—the pith falling out of use, and oftentimes drying up, and the Tree secreting substances which help in the work of consolidating its woody matter. Meanwhile a beautiful office has been filled by the air passing into the leaves through the stomata, and thence at first down certain interstices called *intercellular spaces*, lying between the masses of cells, and on into the tissues of the Tree, helped in its progress, it is believed, by the spiral nature of the threads which are found in the tissues. With the sun's light, acting from season to season upon the gaseous and fluid contributions to the life of the Tree, the whole of the wonderful work has been performed. Cylinder of sap-wood has been added to cylinder of wood; new liber and bark have been successively formed to make room for the increased growth and bulk of the stem and branches.

Each year meanwhile the substance of the roots has been increasing. With the increase in bulk of the older roots, there has been augmentation in the number of foraging rootlets. Hosts of these have been annually formed, and sent out to seek the greater and greater supplies of moisture, impregnated with chemical substances, required by increasing growth. Meanwhile, succeeding spring and summer have increased the breathing power of the Tree by multiplication of the number of its leaves, and consequent augmentation of the green surfaces on which the sun exercises its beneficent and wonderful power. By a wise provision of Nature, the exhaustion of the soil—by the rootlets—of the elements which have ministered to the life and growth of the Tree has been anticipated: for the fall of the leaves each year has brought decay to their tender and delicate framework, which has thus provided the surface soil with the very materials which have been carried up from beneath, and transmuted into the beautiful tracery of the foliage; and in due time, when the subtle operation of Nature called decomposition has been fully effected, the elemental substances of the leaves have, by the gentle influence of rain, been carried down once more into the earth.

Thus it is that, by the combination of these varied and beautiful forces of Nature, exercised during periods of time which are not unfrequently counted by centuries, the Tree has, with gathering and continuous strength, reached the stage of its crowning pride and glory—perfection. Then it is that it most beautifully ministers to the healthfulness and happiness of man—providing him with shelter from the scorching sun during moments when its noon-

day heat is intolerable; with vital air to invigorate the lungs; with refreshing coolness from exhaled moisture; with sweet fragrance from leaf and flower; with fruit from an ample store; and with that inexpressible sense of pleasure conveyed to the mind by the contemplation of the beautiful works of the Almighty Giver of all good things.

CHAPTER VII.

BEAUTY.

How ineffectual are our means of expression to convey to the listener or to the reader a sense of all that is comprehended in the beauty of Trees! We can by our prosaic methods, imperfect though these are, trace the life-history of a Tree so far as we can read and understand it. We can record and illustrate the systematic workings of Nature. We can explain from our own—a necessarily limited—point of view, what has been learnt by patient investigation of the direction and object of natural forces, as exhibited in the plant world—though even in our attempts to trace the operations of Nature we are frequently lost in wondering admiration of the incomprehensible power and of the subtle and irresistible influence exercised by an unseen hand. But the mind falters in attempting even to grasp, much less to express, the idea of the absolute

excellence, of the nameless and indefinable charm, of the deep sense of unutterable pleasure suggested by the presence of Trees.

Trees are always beautiful, and the exhaustless resources of the Creator have been bountifully employed to endow them with ever-changing qualities of loveliness—qualities which are nowhere perhaps more strikingly illustrated than in our own temperate climes, where the alternation of the seasons provides continual variation in the sylvan character of our landscapes. Yet it is difficult to know to what season to apportion the palm of crowning glory, because all the seasons are so beautiful; and it is so often forgotten when the eye perhaps impresses us with what appears to be exceeding beauty, and makes us momentarily feel how much that beauty—by mental contrast—seems superior to that of other seasons, that the present charm is largely due to the impressions produced by the seasons which have just gone, or to suggestions of the sylvan changes which are to come.

Is not the charm of Spring, for instance, largely due to our association of its budding foliage with the bare branches on which the green life of that foliage is first unfolded; to the present contrast of colours between dark limbs and boughs and twigs and glorious green, and to our remembrance of the sweet sleep—the hush, the calm —which have fallen on plant-life during the season of winter, the dream-season of deciduous plants? If it were not for the sleep we should not have the awakening, and the awakening would lose half of its charm.

And how beautiful is the awakening of Spring! Long ere we see the fulfilment of its green promise; long even

ere spreading branches are covered with the budding precursors of their green life, there has been unseen movement within the Tree stems. The sap, the life-blood of the Tree, stirred into activity by the subtle force which throws its mystic influence over the plant world when winter's sleep is wearing off, has been the gentle agent in this movement, and has commenced its ascending course. There has, then, as we have said, been awakening life long ere we have seen its effects. But these at length are manifest. There is gentle pressure from within at ten thousand points on bough and twig; there is swelling of the incipient buds; a bursting of their scaly sheaths; the sweet unfolding of gems of glossy green; the expanding of their incipient parts; and then a burst of verdancy, as Spring, in her full glory, flings her green mantle over the earth.

Then follows the Summer, with rich fulfilment of the promise of spring. The tender gold of the budding leaves is changed to the deeper tinge of glossy green, whose spreading surface has reached its full expansion, when Trees lift their glorious heads against the midsummer sky, and are musical with the sound of the midsummer breeze. And then upon the mass of their expanding foliage there is alternation of sunshine and shadow, giving to the delighted eye every shade of verdancy, with rapid change from silver hues to gold, from thence to brightest emerald, and on to deepest shades of green. There is continual movement too; for even in the greatest heats of Summer, when no breath of air appears to stir the foliage of other Trees, there is gentle motion in the leaves of Birch and Aspen with sparkle of the sheen of their bright foliage.

Then there is the bloom on the blossoms of Summer—blossoms which are the sweet harbingers of the fruit, and touch the mind, through the eye, with a sense of abstract beauty.

Then Autumn comes,

'With less of sweet perfume, but mellower glory;'

and whilst we have the full perfection of this mellow glory in the fruit tinged with richest hues of colour, there is splendour in the leaves dyed with autumnal tints. How beautiful is the autumnal foliage of our woodlands! How great is the beneficence of the Creator to bathe the falling leaves in glorious colours, so that even the sad season of decay may give to the mind a new sense of the loveliness of Nature!

But Winter comes anon. The brightness of spring, the glory of summer, and the mellow beauty of autumn are all gone. The leaves have fallen, and lie scattered and dead on hill-side and in hollow. Yet Trees are lovely still: for then we can see and admire, in full perfection, the exquisite configuration of the forms upon which the summer foliage clusters—the magnificence of their trunks and limbs, the graceful proportions of their branches and boughs, and the fine tracery of their twigs and sprays—defined, as we can often see them, with delicacy and beauty, and with singular clearness against the blue expanse of a wintry sky.

Part II.

FERNS.

CHAPTER I.

INTRODUCTORY.

A WORLD—apart—of dreamy beauty, of soft vapours and chequered sunbeams. A world—below the glare of noon-day—filled with the most delicate and graceful of the forms which Nature's God has made to clothe the earth with a mantle of green. A world where Nature's own sweet music—the silvery music of the streamlet's ripple—falls, gently cadenced, on the ear: or where the stillness

of repose is unbroken, even by the hum of insect life. A world sometimes of darkness relieved but by the faintest gleam of light; sometimes of open rocks and streams, where the roar of the torrent echoes over the mountain side, and rushing water reflects the golden colouring of the sunrays. A fairy world hidden away under the covering of rugged rocks on the sea-shore, beneath moss-covered stones in the river's bed, or in the depths of the primeval forest.

This same world of moisture and shadows is inhabited by various forms of plant life. The mysterious Fungus there makes its home. There, too, the Lichen creeps over its surface of stone or wood, the Sea-weed clings to its dripping rock, and Mosses on floor of earth, wood, or stone, make a soft green carpeting. But above all these forms of vegetation, yet in some degree related to them, stand the Ferns—at once, though flowerless, the most graceful and beautiful of their lower world.

God, in His goodness, has, with a liberal hand, scattered these beautiful plants nearly over the whole of the earth's surface, only the sterile regions of the frigid poles being deprived of them. But their abundance or scarcity in any part of the world depends upon the existence, in greater or less perfection, of those peculiar conditions of growth which these moisture-loving plants require. In Europe, Asia, Africa and America, as well as in the islands of the seas they are to be found, and both in tropical and temperate climes. Over the whole world, more than three thousand distinct species have been discovered; but the variations from the normal forms of these species reach a far larger number than three thousand.

It is curious and interesting to note the proportion borne by Ferns, in those great divisions of the world which we call 'zones,' to flowering plants. Within the colder regions of the polar circles we have seen that they cease to exist. Just outside those regions, but within the boundary of the frigid zones, they are found in the proportion of one Fern to eight flowering plants. In the torrid zone they stand in the proportion of one to twenty flowering plants, whilst in the temperate zones they are in the proportion of one to seventy flowering plants. In England and Wales Ferns are doubly as numerous in relation to flowering plants as in the temperate regions generally, and in Scotland the proportionate number is even somewhat greater as compared with those regions.

But it is in the tropics that Ferns acquire their greatest degree of development, for in the depths of the great tropical forests, under the influence of the prevailing heat and humidity, they attain the size of trees, giving to those forests a strikingly graceful aspect, and even in the open country adding a distinctly-marked element of beauty to the charm of the scenery.

Tree ferns within the Torrid zone grow twenty, thirty, forty, and fifty feet high, often exceeding even that height. Yet, majestic as are these great tropical Ferns when found growing in such situations, and under such circumstances, their size takes nothing from the grace of their forms. Indeed, they are as much superior in grace and beauty to the other arborescent growths of the forest, as the lesser species of this charming order of plants are superior to the rest of the vegetable kingdom. Naturally, therefore, the gigantic fronds of the great tree Ferns wave

more gracefully in response to the gentle motion of the wind than the more rigid branches of other forest tree growths. But their delicacy of form is due to the peculiar conditions under which they grow, and not least to the soft moisture which continually surrounds them. Those of the graceful family which are exposed to the sun's rays, wear a duller hue, and have less of the depth and brilliancy of colour, and less of the graceful drooping habit which are so characteristic of the species which hide beneath the deepest of the greenwood shade, or snugly nestle under the semi-darkness of clefts on the mountain side, or great rocks on the sea-girt shore. Sunshine and the free play of the air give greater stability and rigidity to these plants, but rob them of some of their characteristic beauty. It is the peculiar combination of heat, moisture, and shade in the great tropical forests that encourages not only the most graceful but the most luxuriant growths of tropical Ferns. Such conditions, indeed, are, more or less, always congenial to vegetation, and hence it is that as they abound to so great an extent in the tropics, it is there that we find the greatest perfection in the gorgeousness of Nature's garments. There, too, it is that the animal as well as the vegetable world wears more deep, rich, and brilliant colouring than in our soberer temperate climes. Hence those climes cannot produce the most luxuriant growths of Fern life, or its most brilliant and gorgeous colouring—neither the palm-like arborescent kinds, or the gold and silver species which flourish in the tropics.

We nevertheless possess in our British Ferns a great wealth of beauty and grace, and in some parts of these islands we have them in such profusion as to constitute

a distinct element in the beauty of the landscape, whilst oftentimes in our woods and forests they acquire a luxuriance of growth almost suggestive of their tropical head-quarters.

In whatever part, however, of the world these beautiful plants exist, whether in tropical or temperate climes, they add a singular charm to their surroundings. Even when they grow on some wide expanded heath, under the open canopy of heaven, and in the full rays of the sun, they bring delicacy and grace to the scene, however wild and rugged it may otherwise be. If they grow beneath the shady underwood of a forest, they add a mystic and tender charm to the gloomy beauty of the place. When they are scattered over the great boulders which may stud the roaring bed of a mountain torrent, or are perched on the tiny islets of a gently murmuring stream, they are still the feature of crowning beauty as their waving fronds move responsively to the breeze, and kiss with their delicate tips the tumbling water, as if caressing the element which ministers to the most vital principle of their existence. When they clothe the sides and tops of jagged rocks, they appear as if placed there to soften the ruggedness of the stony surfaces; and when they grow in the clefts of dwarfed or stunted forest trees, they help, in such places, to make amends for the incompleteness of nature, whilst they lend their own half-mystic charm to minister to the pleasure of beholders.

CHAPTER II.

THE GERMS OF FERN LIFE.

In the whole vegetable world there is nothing more beautiful than the process by which Ferns become developed from the almost mysterious atoms, which are, so to speak, the starting-points of their existence. It is indeed nothing less than marvellous that plants of such exceeding beauty and gracefulness, and characterized by such wonderful diversity of form, should be produced from germs which are in most cases almost infinitesimal, or so small as singly to be unseen by the naked eye. In what manner these minute atoms are produced by the parent plant, how nursed upon its fronds, how stored and protected from injury during the process of preparation for that final stage in their germ history at which they

are launched forth to commence a separate existence in the Fern world, we shall subsequently inquire. We have now to speak of the germs as we find them fully endowed by the Creator with the mystic power which enables them to pass through their beautiful and wonderful stages of growth.

Here it will first be necessary to point out that the germ atom of the Fern—beautifully named a *spore*—has little analogy with the seed of an ordinary plant. The spore differs from the seed both in the nature of its construction and in the principle of its growth. A seed is in truth a miniature plant compressed into a tiny space. This plantlet or embryo consists of two principal organs united to each other. The one is the *radicle* or the germ of the future root, the other is the *plumule* or the germ of the future stem, which in the process of development gives rise to branches and leaves, or to smaller stems and leaves. Wherever or however a seed may fall, there can be no change in the respective functions of its radicle and plumule. The one is sure to strike downwards into the soil, and the other is equally sure to rise above the ground.

The spore is not so constituted, nor does it become developed after the manner of the seed. It consists, in fact, of a tiny cell, which is of various shapes in the different genera of ferns, sometimes being globular, sometimes oval, and occasionally angular in form, with an exterior that is sometimes plain, sometimes streaked, or otherwise beautifully marked, and either smooth or bristling with little points. From the part of this minute germ-cell which happens to lie downwards proceeds the

root, whilst from its upper portion proceeds the frond. When the spore has fallen into a congenial position for germination, the process of development commences by the enlargement and multiplication of the cell of which it consists. This cell becomes divided after a short time, and forms an aggregation of little cells, which take the shape, when expanded, of a minute patch, like a tiny leaf laid flat on the ground. This leafy scale, as it may be termed, is mostly irregular in shape, but is usually somewhat round or heart-shaped. Its colour is green, and it bears the somewhat euphonic name of *prothallus*. Under the prothallus—which attaches itself to the earth or rock by fine rootlets—begin to be produced a number of other little cells of a peculiar kind. They are in fact of two kinds, and may be called for the sake of distinction, sperm cells and embryo cells. One of the latter contains a frond-bud or imperfect germ, imperfect because it has to be fertilized before it can commence the process of development. The sperm cells contain minute, active, thread-like bodies called *spermatozoids*. At a certain stage in the germination of the spore, the frond-bud emerges from its cell, and the spermatozoids about the same time issue forth from their cells, and coming into contact with the bud or embryo, the latter becomes fertilized. Soon after this process has been completed, the spermatozoids lose their activity and finally disappear. The prothallus, too, commences to decay, and finally, with its little system of cells, it dies, leaving in its place only the fertilized frond-bud, which, however, at this stage has no defined likeness to the future and complete frond. The under portion of the frond-bud lying next

the damp soil soon, however, begins to form the root-stock, which subsequently gives rise to the rootlets that absorb and convey to the plant the moisture without which it could not live, whilst from its upper portion proceeds the stalk.

Steadily the process of development continues, until at length a tiny Fern is produced, whose form and habit begin to assume a likeness to the form and habit of the parent plant. In all Ferns which are not annual, including the large majority of this class of plants, the process of development is so slow that it is generally two or three years before it is completed. This is the case with the small and herbaceous species, whilst in the case of the shrub-like and the tree Ferns, the period from the commencement to the completion of growth is considerably longer.

Not the least wonderful circumstance in connexion with the minute germs of Fern life is their singular vitality. The dust-like spores, if kept secure and dry for a long period of years, will often, even after such an interval, when subjected to the necessary degree of heat and moisture, commence and continue the process of development.

CHAPTER III.

CONDITIONS OF GROWTH.

THERE is a wonderful adaptation of means to an end in the circumstances under which the germination and development of Fern spores take place. The same conditions of growth must exist for the germ as for the mature plant—Nature having wisely ordered that the spore shall be of such a construction that it cannot survive the influence of conditions which would be fatal to the full-grown Fern.

The conditions essential to the growth of both spore and mature Fern are, generally, moisture, warmth, and shade. Unlike the gayer inhabitants of the vegetable kingdom, Ferns mostly avoid the sunshine and hide in shadow and misty gloom. In such positions it is that

they delight to revel, and though their fronds may sometimes perchance play with the sunbeams, they must have moist crevices for their roots. These cannot indeed survive even the temporary absence of moisture, for in such circumstances they shrivel and die.

We have seen that Fern spores are almost infinitesimal atoms, countless myriads of which when blown from the frond having but the appearance of a tiny cloud of brownish dust. So light are these minute germs that they are readily borne away by the faintest breath of wind. When dispersed from the receptacles in which they have lain ensconced, vast numbers of them undoubtedly perish through falling upon uncongenial soil, or upon 'stony places,' unprovided with crevices moist enough to shelter and nourish the delicate life of such minute germs. But in their very abundance, Nature makes provision for the risks to which they are exposed. The tiniest Fern is provided with the means of producing a vast and uncountable number of germs for the perpetuation and multiplication of its kind; and when the proper moment arrives—that at which the fructification has reached its most perfect stage, and the atomic life germs are separated from the parent plant—the light and aerial messengers are sent forth to seek in every corner of their immediate world for the resting-places which can supply the peculiar conditions of growth that are essential to them.

From what has been said, it will be inferred that Ferns, though hardy in their own particular way, cannot survive an amount of drought that many other plants can bear without material injury. Hence it is only in those posi-

tions in which conditions of moisture can be perpetually maintained that spores can live. Indeed, after germination has commenced they hang upon the threads of an existence which is far more fragile than that of seeds, for the temporary withdrawal of shade and moisture would be fatal to their delicate life.

Spores oftentimes fall upon surfaces which, though sufficiently moist to allow of the commencement and continuation of germination, are not—either from the nature of the soil, or the position—suitable for the proper growth and development of the particular Ferns represented by the spores. Those whose natural habitat is on the spongy soil which lies under the deep shelter of a forest would not find the sides of rock or wall congenial to their growth. The Sea Fern could not live on the expanse of an open forest glade, where the Bracken often grows in wild luxuriance. Nor could the latter thrive on the damp sides of a dark sea-cave. The Fern of the plain is not the Fern of the dripping hollow, nor are the rock and wall-loving species adapted to the soft soil of the spongy hedgetop. It sometimes happens that Ferns which delight in a depth of spongy soil, and in the damp luxuriance of the hedgebank are found growing on the almost bare sides of rock or wall. But in such situations they drag on but an unhealthy existence, and become shrivelled in size, ungraceful in form, and deficient in colouring.

The Common Polypody, the Hartstongue, and the Black Maidenhair Spleenwort for instance, are often found growing in stony places, their rootlets getting what moisture and nourishment they can from the tiny seams

of earth or leafmould in the interstices between the stones. But forlorn-looking indeed are these rock-and-wall-growing specimens compared with those that are found in the moist hollows of pollard trunks, on the dark margins of rushing streams, or in the depths of shady hedgebanks.

CHAPTER IV.

STRUCTURE.

HAVING ventured thus far into the Fern world, we must pause ere we further pursue our explorations, in order to inquire concerning the structure and constitution of its wonderful and beautiful inhabitants. Their position in relation to the rest of the vegetable kingdom we shall discuss anon. Here our inquiry must be limited to the field suggested by the heading of this chapter.

Ferns, as we have seen, stand at the head of their lower world, and hence their structure more nearly approximates to the upper—and sunnier—world of flowering plants than any other members of their class. Like flowering plants, they have roots, stems, and leaves. Let us call the two latter by their proper names of *caudices* and *fronds*. The last-named designation is especially necessary as a means of distinguishing in Ferns those

organs which, though in their appearance the most nearly like what we call leaves in ordinary plants, are nevertheless very different in some important particulars from leaves. The caudex, or stem, is the root-stock of a Fern. From it grow—downwards—the fibrous rootlets, and—upwards—the fronds. There are two principal kinds of caudex. The one is generally upright and trunk-shaped —sometimes, as notably in the case of tree Ferns, raised to some height above the ground; the other is creeping in its habit, and is called a *rhizoma*. The rhizoma in some ferns creeps along or with its circumference half under the surface of the ground. In other Ferns—the common Bracken, is an instance—the rhizoma creeps quite underneath the surface, throwing up its fronds at intervals from the upper side of its surface, and sometimes descending to a considerable depth in the earth, whilst the rootlets, which are thin and fibrous, insinuate themselves into the damp earth, or into the soft veins of rock or stone on which the Fern may be growing, drawing thence by absorption, and conveying to the stem and frond the essential moisture. When the rhizomas merely creep along the surface of the ground, they are frequently furnished with hairs, or thick scales, which give them a shaggy appearance, but serve as a protection to the succulent root-stock which they cover. These creeping stems are of various sizes in the various species, in some being little more than stout fibres, whilst in other species they are thick and fleshy. The rootlets, or root-fibres, are in the same way proportioned to the size of the rhizomas; in the larger species growing to some thickness, and in the smaller ones being but the tiniest

of delicate filaments. From various parts of the upper side of the creeping rhizomas spring the fronds, and it thus happens that, as the former advance—dividing sometimes into branches, and penetrating the soil in all directions—the Fern multiplies, often rapidly, throwing up a miniature forest of waving fronds, and sending into the earth at each point where the rhizoma developes into green life a mass of fibres, which serve at these successive stages to infuse more vigour into the plant.

There is something very beautiful in the arrangement by which Nature provides for the collection by the rootlets of Ferns of the moisture which the latter require for their nourishment. In the earlier stages of growth it is found that the rootlets are mostly supplemented by fine hairs, which cover their surface, and, by capillary attraction—that most mysterious and wonderful power—absorb moisture from every damp surface, either of earth, stone, or rock. As the rootlets acquire age, they become oftentimes tough and wiry, insinuating themselves into the tiniest crevices, and often extending their progress to considerable distances from the root-stock. Should the situation of the plant be such that possible drought might deprive it of moisture, the rootlets, as if by instinct, penetrate deeply into the earth, bank, or rocky seam, in search of distant and moister crevices than those in the immediate vicinity of the caudex or rhizoma. In such cases, and after a Fern has remained undisturbed for years, the great mass of these delicate fibres, ramifying in all directions, constitutes a marvellous and beautiful system, built up as a protection against the Fern's great foe—drought.

Before we conclude our remarks on the root-stocks of Ferns, let us notice those which in a large number of the species are upright in form, and raised above the surface of the ground. Sometimes—and indeed in the majority of instances—they are raised but slightly, often not more than an inch above the ground level or bank on which they are growing. The upper portion of the root-stock is in such cases formed into a crown, which is the basis from which the fronds spring. The crown is practically formed of a circle, or circular cluster of fronds, of the bases of fronds in a fully-developed plant, and of the buds merely of the fronds in an undeveloped or unopened state. Of the position and arrangement of the fronds we shall have more to say anon. Here we desire only to explain how the elongation of the crown is caused. Each year's circlet of fronds as it decays leaves the bases of its stems upon the crown of the plant. These stem-bases, rising each year one stage higher, gradually heighten the crown, the various sets of fronds all leaving their lower parts in continuation of the process. We have already seen that this process is carried on oftentimes, where the conditions of growth are favourable, until the stem of the Fern is raised, as in the gigantic cryptogamic growths of the forest, to a height of as much as fifty feet. And from the crown of the plant at this height continue to be thrown out, as before, a beautiful circlet of fronds. There are some British Ferns which exhibit this same tendency to an elongation of the caudex, and one species exhibits a tree-like stem, which is often raised two feet or more from the ground. But the absence of the extreme heat and moisture of tropical climates prevents the stems of the majority

of our native Ferns from exceeding the moderate length of two or three inches. From the crown of the caudex, and from various points along the upper side of the rhizoma—in Ferns with creeping stems—spring the fronds. These consist of two distinct parts, which may be generally likened to a stalk and a leaf. What would correspond in an ordinary plant to a leaf-stalk is in Ferns named a *stipes*—plural *stipides*—whilst the upper portion, or the leafy expansion, is carried upon an extension of the stipes called a *rachis*—plural *rachides*. In compound fronds the continuation of the stipes, or the mid-rib of the frond, is called the primary rachis. If the leaf be divided, with divisions having mid-ribs branching out on each side from the rachis, these mid-ribs become each a secondary rachis. We return, however, to the stipes, or stalk, of the frond. There is very considerable variety in the length and appearance of the stipes in the various kinds of Ferns. Sometimes it is so short that the lower leafy portion of the frond almost touches the crown of the root-stock. Sometimes it is of considerable length, and indeed there are varying and intermediate degrees of length in the different species. The colour and thickness also vary. Sometimes the stipes is thin and delicate; sometimes stout and fleshy. In some species it is bared of any covering; in others it is densely or sparsely covered with various-coloured, chaffy-textured scales. Sometimes it is extremely brittle and herbaceous, and sometimes tough. Amongst the most beautiful forms of the stipes in Ferns are those which are clothed with scales. Occasionally they are so thickly covered that when they grow up in a close circlet around the crown

they give a curious cup-shaped appearance to the plant, the inside of the cup being a mass of downy scales. The stipes tapers from its base, the rachis also getting smaller towards the apex of the leafy portion of the frond. Both consist generally of tissue—in fibro-vascular bundles—which is mostly of a very succulent nature.

We now come to the leafy, or most beautiful and graceful, part of the frond. Here, in the form and colouring of the various species, we find almost infinite variations. The explanation of all the differences observable in these exquisite organs of Ferns would fill a large volume. Sometimes the leafy portion of a frond is simple and undivided in form, presenting the appearance of an even-edged leaf. Sometimes the leafy portion, though undivided, has its margin beautifully cut in, or indented, the indentation assuming various shapes, often being deeply incised. In other cases the incisions reach down to the rachis, or mid-rib, of the frond. From this form there is an almost infinite variety of divisions of the frond, the rachis, or mid-rib, giving origin to secondary mid-ribs, and these to others branching from them, and so on, each mid-rib bearing its leaflet, or series of leaflets, and the leaflets bearing their more or less indented lobes.

The various divisions of the fronds of Ferns can, however, be most readily understood by the use of two or three simple terms applied in the descriptions of botanists. Where a frond is a single undivided leaf, without any indentations in its margin, it is termed *simple*. If it has a single leaf, deeply incised, but the incisions not reaching

down to the rachis, its form is described as being *pinnatifid*, the expression being derived from two Latin words —*pinna*, 'a feather,' and *findo*, 'I cleave.' Should the incisions reach quite down to the rachis, so as to entirely separate the leafy divisions, the frond is called *pinnate*, and each division is a *pinna*, becoming *pinnæ* in the plural. If, in the same way, the pinnæ are again divided, the term *bi-pinnate* is applied to the frond. When this mode of division is continued through another stage, the frond is termed *tri-pinnate*. If the frond be more than thrice divided, it is described as being *de-compound*. A *pinnule* is the next subdivision of a *pinna*, and a *lobe* the division of a pinnule.

It is the fronds of Ferns which afford the most ready means of distinguishing them from other plants, and the signs of distinction are principally two. The first which may be noticed is the curious way in which fronds are, not folded, but rolled in. When they first start from the crown, they have somewhat the appearance, as they push above it, of a nest of little scaly balls. As they grow upwards, they look like scrolls in process of unrolling, or like the uncoiling of a watch-spring. If the frond be simple and undivided, the unrolling upwards goes on until the whole stipes and leafy portion have been rolled outwards from the base of the stipes to the apex of the frond. If it be a pinnate, bipinnate, or tripinnate frond, the pinnæ, pinnules, and lobes are similarly rolled out from their bases to their apices. It is curious to note in the compound fronds that the processes of unrolling in their upper parts and in their lower or basal pinnæ take place almost simultaneously; for so

soon as the first upward unrolling in the direction indicated by the stipes and the principal rachis has liberated the lowest pinnæ, these commence to unroll, whilst the primary unrolling is continuing upwards: and the next and succeeding pinnæ above the lowest commence one after the other, as they are alternately unrolled, the same process. In the same way also, so soon as the pinnæ, beginning with the lowest, which are always, as we have seen, the first to be liberated, are left free from the principal coil of the frond, they, if compound—i. e. containing pinnules and lobes—set in motion the same process, the first unrolling taking place—the unrolling being always from base to apex either of pinnule or lobe —at that part of the pinna next the principal rachis. The unrolling by alternation goes on in the same manner throughout the whole length of the frond, the highest pinnæ being the last to be unrolled. Briefly, then, the process may, as we have seen, be described to be—in fronds other than those which are simple—the unrolling of the principal coil from base to apex, followed in alternation by the lateral and perpendicular unrolling of pinna, pinnule, and lobe.

The chaffy and various-coloured, though usually brown or rust-coloured-scales, which, as we have noticed, are frequently found clothing the stipides of Ferns, are, in a number of the species, continued along the backs of the rachis and its branches, sometimes covering the entire under-surface of the fronds, and giving to them, in such cases, a remarkably hairy or shaggy appearance. In some of the species the scales give a singularly beautiful appearance to the fronds. As to the size and arrange-

ment of these scales, they are found to be largest at the base of the stipes, getting smaller upwards, and being smallest at the highest point of the primary rachis, and at the points farthest from the bases of its branches.

We have now to indicate the characters which especially serve to distinguish Ferns from other plants. Under what is called the 'natural system' of botany the vegetable kingdom is divided into two great groups of plants, namely, flowering and flowerless plants. At the head of this latter division stand the Ferns. These beautiful plants, however, though flowerless, are seed-bearing. But they do not get their seeds, like other plants, through the medium of flowers, for the curious fact is that their seeds or spores are always, under a very beautiful but singular arrangement, borne either upon the backs or on the edges of their fronds. The vegetable tissue of which the fronds of Ferns are composed is traversed by a series of veins arranged sometimes in parallel lines, sometimes being forked in various ways, and at other times variously radiating from the bases to the edges of the pinnæ, pinnules, or lobes. The seed-clusters are generally borne upon or attached to the veins at the backs of the fronds, although in some instances the *receptacle*—the name of that portion of the veins to which the spore cases are attached—is projected beyond the edge of the fronds.

The particular form and position of these seed-clusters serve as a means of classifying Ferns, or enabling them to be grouped in accordance with a convenient arrangement. When they are borne upon the back of the frond they are usually arranged either in lines or in heaps.

Sometimes they are arranged in a double row along each side of and parallel with the mid-ribs of the pinnæ; sometimes in double rows on each ride of the mid-veins of the pinnules; and sometimes they form two lines which meet at an angle on each pinnule, the point of union of the lines being towards the apex of the pinnule. In other cases they form oblique lines on each side of the mid-veins, the lines starting from near the mid-veins and proceeding outwards to the edges of the pinnules. Sometimes they almost completely cover the under-surface of the pinnules of the frond, whilst occasionally they are in turn themselves concealed by a dense cloud of scales which thickly cover them. Again, in some cases they are borne along the outer edges of the under-surface of the pinnules or of the lobes of the pinnæ, and sometimes, as we have seen, they are projected beyond the leaf margins.

The manner in which the spores are collected on the backs of the frond is extremely curious and beautiful. They are contained in little cases which are known by the name of *sporangia*—singular, *sporangium*, which means 'a spore vessel.' The sporangium is of a thin or horny texture—sometimes semi-transparent, and sometimes opaque—usually consisting of a single cell, and generally either globe-shaped, pear-shaped, or oval. Sometimes it is furnished with a very short stalk. There are two kinds of sporangia in Ferns, the one kind—including the great majority of known Ferns—being surrounded by a jointed elastic ring which passes round the sporangium, either in a horizontal, a vertical, or an oblique direction, whilst the other kind is altogether destitute of a ring. The

collection or cluster of spore cases is often arranged under the protection of a scale-like covering called the *indusium*. Where this organ is present, it continues to cover the clusters of spore cases until the development of the latter bursts the membranous scale. Each separate cluster of spore cases whether covered or not is called a *sorus*, from a Greek word which means 'a heap'—plural, *sori*. Some Ferns, however, have no indusia over their sporangia, the latter being naked or non-indusiate. When the sori are what is termed *marginal*, that is to say, when they grow along the extreme outer edges of the backs of the pinnules, it often happens that the leafy margin of the pinnule is turned back to cover them and to serve as an indusium.

In the case of those Ferns whose sori are covered by indusia we have seen that the growth of the spore cases acting upon the indusia bursts the margins of the latter, which are then either wholly or partially thrown off. Subsequently the bands or jointed rings which encircle the spore cases either vertically, horizontally, or obliquely, are burst by the elasticity of the rings, and the fine dust-like spores are dispersed. Sometimes the indusium takes the form of a cup or urn in which the spore cases are contained, and which in the same way at the proper season liberates the latter by bursting.

Some Ferns possess two kinds of fronds, barren and fruitful, the former bearing spores, and the latter being without them. In some instances the two kinds of fronds are not distinguishable from each other. But in other instances the form of the fruitful frond materially differs from the barren one. The relative lengths of the stipes

and of the leafy portion in fronds vary considerably in different species. Sometimes they are equal, sometimes the stipes is much longer than the leafy part of the frond, and sometimes the contrary is the case.

CHAPTER V.

CLASSIFICATION.

A DEEPLY interesting study is here opened up for the lover of Ferns. These beautiful plants do not consist of a confused mass of individuals, possessing no resemblance to one another, and having no characters in common. They bear such distinct relationship to each other as to admit of their being arranged systematically into various large and small groups.

If we regard the whole Fern world as itself but a *class* in the sub-kingdom of cryptogamic plants, we shall find that this class will admit of being further divided, according to certain well-marked characters of the groups composing it into *orders*. The orders, in turn, admit of further grouping into *genera*—singular, *genus*, the latter

into *species*, and species into *varieties*. Let us, for the moment, lose sight of the minute division of our flowerless plants into varieties, and regard only that aggregation of individual plants which is termed a species. A species, then, includes an assemblage of individuals, which, generally speaking, may be said to closely resemble each other. The accidental circumstance of size may temporarily prevent actual or immediate resemblance. But it is assumed, for the sake of the comparison here instituted, that two individual plants of the same species, of the same age, and growing under precisely the same conditions, are alike. If between individuals so closely resembling each other there are certain minor, though well-defined and tolerably constant distinctions, these constitute what are called varieties. Ascending, however, from the collections of individuals which we range under species, we come to what is called a genus—a term which includes one or more—generally more than one—species. A collection of species having certain marked and important points in their structure in common constitutes a genus, and an assemblage of genera, differing in many respects from each other, but still having certain features in common, constitutes an order. By such a method of arrangement or classification we are enabled to group the inhabitants of the Fern world, and exhibit the relationship which exists between them.

It will now be interesting to inquire what are the points of resemblance or of disagreement which suggest the inclusion or the exclusion of certain forms of Fern life under or from particular orders or groups. Before the time of the great Swedish naturalist, Linnæus, a rude and

imperfect system of classifying plants had been adopted. The rougher features of Ferns, for instance, were selected in order to facilitate and guide systems of classifying them. When it was found that there were points of resemblance in the general appearance of the fronds and in the habits of the plants, the fact was considered sufficient to warrant their classification in groups, marked by these general or rough characterizations.

Linnæus, however, and those who followed him, invented and perfected between them a system of classifying Ferns in accordance with the points of resemblance suggested by the shape and position in the several species of the seed clusters, which in general pass under the name of the *fructification*. As the fructification of Ferns takes place upon some part—either in the middle or at the ends—of the veins which intersect the leafy substance of the fronds, the particular character of the veining of the fronds has formed one means of establishing a basis of classification. But the chief mode of distinction or association has been suggested by the presence or by the absence of the scaly covering of the seed clusters, which, as we have seen, is called the indusium, as well as by the form of the latter, and the particular manner in which it may be disrupted when the time arrives for the ripening and setting free of the spores.

If we take those inhabitants of the Fern world which are to be found in Great Britain, Ireland, and the Channel Islands, we shall find that the whole of them may, under the system of classification based on the form and arrangement of the spore cases, be included under three principal groups comprehending lesser

groups, which, in their turn, comprise genera, containing a varying number of species. The primary groups, which, as we have seen, are three in number, are called—1. *Polypodiaceæ*, a group containing ten lesser groups, including sixteen genera and forty-one species, and comprising Ferns whose fronds are, on starting from the crown, found to be rolled up in a circinate or scroll-like manner, and having their spore cases surrounded by an elastic ring, which, when it bursts, does so by a transverse fracture. 2. *Osmundaceæ*, comprising in Britain only one genus, of which there is but one species. The group, however, comprised under Osmundaceæ includes Ferns which, although their young fronds are rolled up like those included under Polypodiaceæ, have no elastic ring around their spore cases, the latter consisting of two valves, bursting in a vertical manner. 3. *Ophioglossaceæ*, comprising two genera and three species in Britain, and including Ferns whose fronds are not rolled in, in a circinate or scroll-like manner, but are folded up straight, and whose spore cases are—like the Ferns comprised under Osmundaceæ—deprived of an elastic ring, and two-valved.

CHAPTER VI.

DISTRIBUTION.

We have seen that Ferns are distributed all over the surface of the world, both on continents and islands, with the exception of the sterile parts of the polar regions. To give, therefore, in detail, a mere list of the numberless localities in which they are to be found would necessitate the space which a library of volumes alone could afford; and such a list could never be complete, because the limits of the Fern world are continually being extended under the operation of the almost infinite power of reproduction possessed by these beautiful plants. Wherever the conditions of existence continue to be favourable, Fern life is

maintained; and whenever such conditions are created in localities where they did not previously exist, there, in course of time,—the interval depending on the proximity of ferny growths,—forms of Fern-life will appear. Hence no mere dry and detailed list of the habitats of Ferns throughout the world would possess much permanent utility; and such a list, if full and complete, would, as we have said, vastly exceed the limits of the present volume.

The object of this chapter will be to indicate the situations in which Ferns love to grow, having regard to the general character or nature of the locality, the aspect, the position in relation to the surface of the ground, and to the natural features of the country, and to the nature and constitution of the soil. If this part of the subject be mastered—and there is little difficulty in mastering it—the reader will know, wherever he may chance to be, whether he is in or near the confines of any portion of the Fern world; and when once he has carefully noted his whereabouts, he can easily ascertain whether the conditions which promote ferny growths are present or absent.

Ferns are associated with the most beautiful portions of this world's surface. The most graceful of Nature's garments, they seek to clothe, not the dull expanse of level plain, or the bare, straight side of hill or mountain. They do not grow on sandy flats, on the even margin of a sluggish river, or on the smooth and rockless lines of sea coast. Where the scorching sun-rays fall unscreened upon arid earth, and where no shadows relieve the course of a far-reaching expanse of open country, no ferny growths are found. It is where Nature is in her wildest moods, and assumes her grandest aspects, or where the

beauty which is spread over rock and wood and stream is of that dreamy kind which most powerfully stirs the imagination and enthrals the soul, that ferns are found in the greatest perfection, waving their graceful fronds in response to the mountain breeze, or bending under the weight of spray-drops flung upon them from the impetuous mountain torrent.

Ferns love to grow where the land is musical with running water; where great woods fling their shadows upon the hillside, and hang darkly over stream-crossed valleys; where rivers, wandering over the crests of towering rocks, and leaping from the sunlight, fall foaming into dark pools, bristling below with sharp points of stone, to be carried thence in fury, down steep inclines to the sea; where for long miles the landscape undulates into heathery waves, broken by clumps of gorse on rocky mounds, sheltered by prickly hawthorn or trailing sprays of blackberry; where undulating meadows, cleft into many a sheltered hollow, roll gracefully away as far as the eye can reach; where storm-tossed waves roar upon the rugged points of a rocky coast, and echo into many a cavernous hollow moist with the perpetual droppings of percolating water; where, in short, mountain and valley or hill and glen commingle; and towering rocks or stately woods, jutting knolls and arching branches, play with sunshine and shadow, and caress the sides of running streams, whose sparkling waters give birth to soft, moist vapours.

Enough has been said to show that Ferns delight in moist and shady places, and, thoroughly in keeping with their soft and graceful habit, they love light and porous

soils where their roots can keep free from stagnancy. On shady slopes and modest elevations they mostly like to dwell. Fibrous peat and sand, and the spongy mould of fallen leaves, form soils in which these plants delight. Through such soils water always percolates freely; for stagnant moisture is fatal to Fern life. Hence the sloping sides of a mound or hedge-bank; the crest and sides of rocky elevations; the forks of trees where leaf-mould has accumulated; the shaded margins of running brooks or larger streams; the moist caverns in the sides of cliffs above the tide-mark; the mossy crests of islets in mid-stream; the sloping, sheltered hill-sides; even the moister hollows of the plain, and the broken depths of forest glades and forest coverts, are the sites which are most congenial to ferny forms, and most which readily adapt themselves to ferny growths.

It will be seen that the presence of Ferns in any place assumes the pre-existence of conditions favourable to their growth. They are never found absent from an old forest. Let us inquire the reason of this, and examine into Nature's preparations for their reception. The presence of clustered trees for a long period of years gives rise to the formation of a surface soil which is composed of the decomposed remains of the crops of leaves which, in the deciduous species of trees, annually fall to the ground. Leaves upon leaves accumulating form the most perfect vegetable mould, and this, built up upon the porous subsoil, and largely intermixed with the root fibres of plants which have sprung up and died down each year, constitutes a soil—at once rich, light, and porous—in which Ferns especially delight. The

sheltering canopy of trees, whilst it keeps out the sunlight, keeps in the moist emanations from the ground, and thus creates other conditions which are essential to Fern life. Within a forest the ground is generally uneven and diversified. Banks of rock or earth are found scattered about—the former cleft into various shapes, forming hollows and crevices of various kinds—the latter mostly covered by some species of vegetation of dwarf or shrubby growth, and overarched by the taller growths of the forest. In the hollows and crevices of the rocks, and upon the top and sides of the earthy banks leaves perpetually fall and decay, and in course of time form a leafy soil, which mingles with crumbling rock or earthy granules, it may be, of sand or gravel. Upon such places Fern spores drop, and find the situation suited for them by reason of its moist and sheltered position. Soil and position being congenial, the spores develop into plantlets, and these in time into full-grown Ferns. The conditions which favoured their early existence are maintained. The soil is annually enriched by additional deposits of leaf-mould, and, the moisture and shelter continuing, the Ferns grow to maturity, and then spread their myriad atoms of reproduction, which, wafted to other rocky holes, moist banks, and old, moist forks of trees, soon fill the forest with graceful ferny forms, covering sloping banks, waving from the crowns of pollard trunks, and draping rock and river with their feathery tresses.

Or take the case of a stream which flows rapidly through a mountain gorge, or along the boulder-strewn bed of a valley. Vegetation of large growth—trees or

giant shrubs—will follow the course of such a stream, for its moist channel is favourable to the development of vegetable life. The stream brings moisture; the trees or other growths bring shelter; the force of the current makes and maintains holes and fissures in its earthy or rocky bed. These are filled with leaf-mould from dropping leaves, and with sand and fibres from the carrying stream. Then Nature begins her work, and plants her smaller growths of moss, lichen and Fern on the dark moist surfaces of earth or rock. The process of dwarf-forestry commences, and slowly and surely the whole ground-plan is draped with a mantle of living green.

Chance, perhaps, has thrown together in mid-stream some shapeless masses of rock: the water brings down a contingent of broken branches torn from their parent stems by the force of high winds, or fallen under the process of natural decay. The jutting masses of stone arrest the woody fragments, and these in their turn catch the passing whirl of stream-borne leaves, and dam the earthy substances washed down from the banks of the stream above. A process of accumulation commences. The mass thickens and strengthens, and some bold plant starts up from its centre. Others follow, and their matted roots consolidate the substance, which by degrees acquires increased consistency and becomes an islet. Amongst the earliest of vegetable inhabitants are the mosses and lichens, and then the domain is appropriated as another portion of the Fern world by the appearance of some representative of the moisture-loving family.

Again, the face of the country may be traversed by gentle risings of the ground, and intersected by hedge-

banks dividing the domains of pasture or corn land, and skirting a network of roads and lanes. If the soil be rich, and the roadways narrow, the banks of earth or loosely-built stone may be crowned by stately shrubs or trees, whose branches cross the way between and meet each other. Then upon the hedge-top, or on the hedge-bank, leaf-mould gathers, and ferny forms assemble and greet the passer-by.

Let it be remembered, however, that the various members of this beautiful family of plants have varying predilections in the matter of soil and position. Some seek the drenchiug moisture of the waterfall, or the dripping walls of sea-caves. Others can live and thrive in the moderate moisture of sloping banks under the shelter of shrubs, or trees, whilst others still will grow on the open surface of an undulating plain. But, with few exceptions, Ferns mostly love to be elevated, even if but slightly, above level surfaces. It is percolating moisture which they love—moisture which does not rest about their roots, but passes away immediately into the soil below. And there is a beautiful consistency in the love of these plants for sloping banks and jutting knolls, for only in such positions can they show to advantage their graceful and beautiful forms.

CHAPTER VII.

USES.

Those who have been fairly inoculated with the love of Ferns, will be interested to learn that many species of these beautiful plants are used not only for food and medicine, but for economic purposes. As food, they are chiefly useful to the aboriginal inhabitants of some foreign countries. In the larger of the exotic Ferns—the tree-like species—the inner part of the stem, stipes or rhizoma—corresponding to what would be the pith in other plants—and sometimes, the whole of the tuberous rhizoma, is eaten generally after being boiled. In India, some of the natives boil the tops of one species of Fern, and eat it with shrimp-curry. Amongst ourselves, two of the most

beautiful species—the Bracken and the Male Fern—are said to have been sometimes used as ingredients in the manufacture of beer; whilst one foreign species (*Aspidium fragrans*) is actually stated to have been used for making tea. Our native Maidenhair used at one time to furnish a principal ingredient for a syrup called 'capillaire,' which can be made in this way:—To one ounce of the fronds of the Maidenhair must be added a quarter of an ounce of liquorice-root, and one pint of boiling-water. The ingredients after standing six or seven hours should be strained, and to the resulting liquor must be put one quarter of a pint of orange-flower water and two pounds of loaf-sugar.

But it cannot be contended that Ferns can compete with other plants as articles of food for man. They have, however, a greater repute as items in the pharmacopœia of the herbalist, on account of the medicinal properties possessed, or supposed to be possessed, by many of the species. In the economy of the arts and manufactures, they find, too, a place. Let us notice the chief uses, in the senses indicated, of some of the most familiar of our ferny forms.

We will take first the Male Fern (*Lastrea filix-mas*). In Siberia it is said to be used in brewing, on account of the flavour which it imparts to ale; whilst in Norway the incipient fronds in their unfolded state are plucked, boiled, and eaten as a kind of 'asparagus.' They are even preserved in a dry state, when gathered in the summer; and, when winter comes, are given to cattle after being soaked in boiling water. In many countries this Fern has been regarded as a powerfully astringent

medicine, especially valuable as a vermifuge—the part used for that purpose being a powder made from the dried root-stock, and administered with syrup, treacle, or jelly, as an electuary. Culpeper avers that being burned, 'the smoke thereof driveth away serpents, gnats, and other noisome creatures which in ferny countries do in the night-time trouble and molest people lying in their beds with their faces uncovered.' As it abounds in alkali, it is also used in the dressing of leather, in the manufacture of soap, and for other purposes.

Our native Brake (*Pteris aquilina*), a Fern common to many parts of the world, has uses very similar to those of the Male Fern. In parts of Normandy it has been, it is stated, used as food. In the more northern countries of Europe, it is used in the manufacture of beer; the proportion used for brewing being one part of the rhizoma to two parts of malt. Pigs, too, will eat the roots readily if they are boiled with their other food; and we have often seen the green fronds cropped, with satisfaction, by horses. The ashes of the plant, when burnt, make a valuable manure, being especially recommended as favouring the growth of potatoes; and for the reason, that they contain a very large proportion of nitrogen. They are also sold to glass and soap makers; and in some parts of the western isles of Scotland, their collection and sale form the staple of a regular industry. Mixed with water, and dried in the sun, they make balls which are used by the inhabitants of some parts of North Britain as soap for the washing of their clothes. Being, like the Male Fern, a powerful astringent, the Bracken is useful in the manufacture of leather. Besides furnishing, when dried, a

light fuel to the rural population, in some districts it is used for the thatching of houses. If the young shoots are gathered and simmered in water over a fire for two or three hours, the liquid makes, when cold, a kind of jelly which is recommended as fattening food for pigs. The fattening quality of this Fern no doubt arises from the fact that it, like the Male Fern, contains an abundance of starch. Like the Male Fern, also, it has been used as a vermifuge. But of all the uses to which the Brake is put, none is so familiar as its employment for the packing of fruit; and there is a well-founded belief, that its utility in this way is due to its power of resisting mildew, and keeping fresh the articles packed in it. This belief may account for the circumstance that it has been used in the Isle of Man for the packing of freshly caught fish. It is believed, too, to possess great virtues as a covering for potatoes, when the latter are buried in the ground; and it has been noticed, in many cases, that it keeps these tubers very much better than straw, or any other article used for covering them. But, perhaps, the most pleasant association of the Bracken in the public mind is with fragrantly-scented strawberries in the early summer season. Who is not familiar with its fronds in this way?

The root-stock of the Royal Fern (*Osmunda regalis*), was in times gone by reputed to possess the quality of healing wounds, whether applied to them externally, or taken inwardly in the form of a decoction. Its outward application was considered a specific against bruises or sprains, and good for bones broken or out of joint; and, taken inwardly, it was also believed to be good for colic and for splenetic disorders. In some parts of Europe

its root-stock is said to be used, after being boiled in water, for the purpose of starching linen.

The reputed power of curing splenetic diseases has given to a group of Ferns, many species of which are natives of Britain, the name of Spleenworts. Some of them, indeed, were at one time believed to be effectual in cases of cough and asthma, and for scorbutic complaints. One species, the Common Maidenhair Spleenwort (*Asplenium trichomanes*), is used in some parts of the Highlands of Scotland, in the form of tea, for the cure of coughs and colds; and in a herbal, published three centuries ago, the virtue of keeping the hair from falling off, and restoring hair in the place of that which had fallen off, was ascribed to the same Fern. A gummy extract to be obtained from the Sea Spleenwort (*Asplenium marinum*) was also considered some hundreds of years ago to afford—if applied outwardly—great relief from burns, even when all other applications had failed. The virtue of effectually benefiting persons attacked with splenetic disorders has also been ascribed to the Hard Fern (*Blechnum spicant*). The Scaly Spleenwort (*Asplenium ceterach.*) is used as bait for rock cod on some parts of the Welsh coast. It is also, according to Culpeper, considered to be a remedy for 'all melancholy diseases' if the 'herb and roots' be 'boiled and taken.'

A pleasant and familiar inhabitant of our lanes and woods—the Common Polypody—(*Polypodium vulgare*) has had ascribed to it, by ancient herbalists, various medicinal qualities, amongst them being the power of curing coughs and asthmatic affections, the dried rhizomas being powdered for the purpose and mixed with honey.

Finally, to two or three Ferns common in many parts

of England, the Moonwort (*Botrychium lunaria*), and the Common Adders-tongue, various wonderful properties have been ascribed. The Moonwort has been considered an antidote for wounds, and the Adders-tongue—'an herb,' according to Culpeper, 'under the dominion of the Moon and Cancer'—is supposed to owe its name to its reputed power of curing the bites of adders and of other reptiles. From it an ointment is made called adders-spear ointment, which is supposed to be a specific cure for recent wounds, and is a good deal used as a popular remedy for them. It is made, according to Culpeper, of 'the leaves, infused or boiled in oil, omphacine, or unripe olives,' set in the sun for certain days, or the green leaves 'sufficiently boiled in the said oil.' He says, that amongst other things it 'helps sore eyes;' and if the juice of its leaves be drunk with 'the distilled water of horse-tail,' it 'is a singular remedy' for 'all manner of wounds.'

Culpeper gives a quaint and curious account of the Hartstongue. He asserts that 'Jupiter claims dominion over this herb,' and he adds, 'therefore it is a singular remedy for the liver, both to strengthen it when weak and ease it when afflicted.' He recommends that 'you shall do well to keep it in a syrup all the year; for, though authors say it is green all the year, I scarce can believe it.' Such a recommendation may indeed well be adopted; for we go on to read that the distilled water of Hartstongue is 'very good against the passions of the heart,' as well as 'to help the failing of the palate.' It is also good, according to the Grecian botanist Dioscorides, against 'the stinging and biting of serpents.'

The quaint writer already referred to—Culpeper—speaking of the 'Maidenhair,' which is evidently the Common Maidenhair Spleenwort (*Asplenium trichomanes*)—and of the Wall-rue, or 'White Maidenhair' (*Asplenium ruta muraria*), says that decoction of either 'being drunk, helpeth those that are troubled with the cough, shortness of breath, yellow jaundice, diseases of the spleen, etc.' Further, it 'cleanseth the lungs, and by rectifying the blood, causeth a good colour to the whole body,' and 'the lee made thereof is singular good' for staying the 'falling or shedding of the hair,' and causing it to 'grow thick, fair, and well coloured,' for which purpose 'some boil it in wine, putting some smallage seed thereto, and afterwards some oil.'

A number of remarkable qualities are ascribed, by Culpeper, to the Three-branched Polypody or 'Polypody of the Oak,' as he calls it (*Polypodium dryopteris*), which is, we are told, especially good for 'those that are troubled with melancholy or quartan agues.' For application to such purposes it should be taken 'in whey, or honied water, or in barley water, or the broth of a chicken with epithymum, or with beets, and mallows.' 'It is good for the hardness of the spleen, as also for the colic.' The distilled water, both of roots and leaves, besides being good 'against melancholy,' is 'good' also for 'fearful and troublesome sleeps or dreams.' If this distillation have sugar-candy dissolved in it, it is 'good against cough, shortness of breath,' and consumptive tendencies. If the fresh roots be 'beaten small,' or the powder of the dried roots be mixed with honey, it will greatly 'help' a member which is out of joint.

CHAPTER VIII.

THE FOLK-LORE OF FERNS.

It would have been strange indeed if plants so fairy-like in form as Ferns had remained free from all association with the mysterious region which we call fairy-land. Fern-land by day must have been a veritable fairy-land at night; and the graceful companions of Queen Mab doubtless disported themselves ecstatically amongst the feathery foliage of the shade-and-moisture-loving plants.

The fairies must indeed have had an especial fondness for ferny forms, for they chose the twin leaflets of one of the graceful family to saddle their horses with. Shakespeare tells us of Queen Mab, that her waggon spokes were

> 'Made of long spinners' legs;
> The cover, of the wings of grasshoppers;

The traces, of the smallest spider's web;
The collars, of the moonshine's wat'ry beams;
Her whip of cricket's bone; the lash of film:
Her waggoner, a small grey-coated gnat,
Not half so big as a round little worm
Prick'd from the lazy finger of a maid:
Her chariot is an empty hazel nut,
Made by the joiner squirrel, or old grub,
Time out of mind the fairies' coachmakers.'

But sometimes when riding alone, she saddled her steed with the twin leaflets from the spike of Moonwort. Now this little Fern grows apart from its kind, on the open face of meadows, under the play of the moonbeams. Look, gentle reader, at its leaflets, and you will see how suggestively they shape themselves into the form of a diminutive saddle, and how temptingly they spread themselves out and away from the upright stem of the plant, as if inviting a fairy's leap from the fruit-spike! The barren frond would saddle easily half-a-dozen fairies, each pair of leaflets forming a saddle, the neck of which would consist of the mid-stem of the frond where it joined the bases of the opposing pinnules.

Why, however, did Queen Mab select the Moonwort's pinnules for her saddle? When duly equipped, we know that she gallops

'Night by night
Through lovers' brains, and then they dream of love:
On courtiers' knees that dream on court'sies straight,
O'er ladies' lips who straight on kisses dream.'

And access for the fairies was to be obtained to the brains of lovers and the lips of ladies, even when the latter were safely locked in their chambers, by the powerful aid of the Moonwort saddle; for does not an ancient writer tell

us that 'It is believed by many that Moonwort will open the locks wherewith dwelling-houses are made fast.'

Another mysterious power was ascribed to this Fern, as indicated by the following lines by the poet Withers :—

> 'There is an herb, some say, whose virtue's such,
> It in the pasture only with a touch
> Unshoes the new-shod steed.'

And so great in other ways was its potency that alchymists and witches included it in their herbals.

It is not surprising that some three hundred years ago a good deal of mystery was believed to surround the seeding of Ferns. It was superstitiously considered that these plants were propagated by invisible seeds, although it was thought that the 'black spots' which were found on the backs of their fronds had something to do with their seeding capacities. It was believed that these 'black spots' fell suddenly upon the Ferns on Midsummer Eve, and that if they were then gathered under certain conditions, they would produce on the gatherer some very potent effects, the chief of which would be the ability to walk invisible. To get the gift of invisibility, however, it was necessary to proceed to 'catch' the Fern seed in the following way. Twelve pewter plates were to be taken at midnight of St. John's Eve, and placed under the 'black spotted' frond. The seed then in falling would pass through eleven of the plates, and rest on the twelfth. Fairies, however, were sometimes in attendance to snatch the seed away as it fell. But if the gatherer succeeded in his attempt, he would thereafter possess the much-coveted quality of invisibility.

Some curious adventures, however, happened to some of the would-be Fern seed gatherers. One person declared that whilst occupied in gathering it he felt unseen spirits whisking by him, and occasionally striking his hat and parts of his body. After awhile, however, having borne this ordeal with patience, he went away, carrying with him, as he thought, an abundant supply of seed. But lo! when he reached home he found the papers and box in which he had carefully secured it perfectly empty. It is recorded, too, that 'a respectable countryman, at Heston in Middlesex, stated that in June, 1793, when he was a young man, he was often present at the ceremony of catching the Fern seed at midnight on the Eve of St. John the Baptist. He records, however, that the attempt was often unsuccesful, for the seed was to fall into the plate of its own accord, and that too 'without shaking the plant.' Even in the present day this superstition is not exploded, for it is alleged that in some parts of the country—notably in Worcestershire, the country people still keep up their belief in the mystic power of Fern seed to convey the gift of invisibility.

CHAPTER IX.

FERN HUNTING.

The study of Ferns can be pursued in three different ways. It may be pursued in the chamber of a botanical recluse, with the aid of every scientific appliance, and with an abundant supply of dried plants, with their fronds, caudices, and rootlets. It may be pursued in the Fern-house or garden, or over that microcosm of the Fern-world, the case, or pot. Each of these ways of following this study is interesting and instructive.

There is, however, yet another way of pursuing this delightful study, and that is, in the home of the Ferns. Perhaps the severe votary of science may object to the proposal to associate Fern hunting with 'study.' It is too frequently the custom of our botanical writers to describe with painstaking minuteness only the structure

and peculiarities of the organs of plants—to present to us, in short, the 'dry bones' of organography, but to tell us nothing of the *life* of plants. They give us a fragment of dried rootstock and frond or leaf, but will not provide any *colouring*, even as a background or as a framework to their picture.

By Fern hunting, we do not mean the mere search for 'botanical specimens' of Ferns, to be secured merely as an aid to the mastering of the technology of cryptogamic botany. We would have the expression to bear a much wider meaning. To the lover of Nature, it will suggest not merely the study of the habits of Ferns—a study, under its most delightful aspects, of the most graceful of the shade-and-moisture-loving inhabitants of the plant world. It will suggest abundant opportunity for the study of the general features of Nature—her mountains, her valleys, her clustering woods, with their roaring torrents, or gently murmuring streams.

CHAPTER X.

FERN HOLIDAYS.

As we commonly see plants and shrubs in our towns, we notice an absence of that exquisite freshness of aspect which they wear in their native wilds. The purest air and the most perfect soil, and absolute freedom from the deteriorating influences of town life, produce, too, a beauty and elegance of form which cannot in their full perfection be attained under other circumstances. It is thus, at any rate, that God intends Nature to be, and not to wear the deteriorated aspect which it too often does when brought into association with man.

How delightful, then, to seek the opportunity of studying Nature in her simplest, yet her most fresh and

beautiful aspects! And what so likely to conduce to the most perfect enjoyment of such wanderings afield, as the association with our rambles of some definite object? The 'rural walk' through lanes—

'O'er hills, through valleys, and by river's brink,'

will be far more enjoyable if, for instance, it be made the occasion of a search after Ferns.

A search for Ferns as the object of a country ramble will lead people into the woods and lanes, into the combes and dells, amid rocks and waterfalls, where there is the purest air and the most beautiful scenery, and where, consequently, relaxation being of the most pleasant kind, will the more certainly benefit the health both of mind and body. The rarest Ferns, and the greatest abundance of the more plentiful kinds, are to be found in the wildest haunts of Nature, lying in regions far away from the habitations of man. To the rich, such far-reaching rambles will be easy of attainment. But even to the poorest, there will often come opportunities for indulging to some extent in this delightful pastime; and with a taste for Fern hunting, will naturally come a love for other of the beautiful works of creation; and the heart will be lifted up in thankfulness to the wise Giver of all good things.

CHAPTER XI.

FERN COLLECTING.

Pleasant visions at once rise before the mind's eye; visions of rambles among rocks on the sea-girt shore; through winding mazes of green lanes; through ferny hollows; up ferny hills; over moorland and meadow; by the daisied margins of gurgling brooks; by the rocky borders of a mountain stream; into the deepest shade of spreading woods.

But here we purpose not to recapitulate the fresh delights of Fern collecting, but to give the collector such needful suggestions, and offer such careful guidance as may be of service in the practical pursuit of one of the most delightful of occupations.

With opportunities, either great or small, for seeking Ferns in their native wilds, how and when can they best

be removed from the places in which they grow to the garden of the cultivator? These are points with regard to which practical suggestions will be serviceable. And first of all as to the season for transplanting Ferns. The winter season during the prevalence of mild weather is unquestionably the most suitable time for removing them. The next best time is the early spring, just as the new fronds are about to commence their growth. But those who are not experienced collectors might at such seasons often find a difficulty in recognizing some species, because of the fact that the parts which afford the most easy means of recognition—the fronds—are dead. The evergreen species mostly retain their fronds all the winter, and would, therefore, be easy to find. But it is not so, of course, with the deciduous species, which include the most fragile of the herbaceous kinds.

Ferns, however, are so hardy that not only in winter and early spring, but throughout spring, summer, and autumn, they can be uprooted and transplanted with but little injury, beyond perhaps the disfigurement of one or two of the growing fronds. And even this minimum of injury may be avoided by very careful handling, though, should it be inflicted, the plant will not be long in supplying the place of its lost fronds.

We may look upon Fern collecting therefore as a delightful pursuit, which can be followed all the year round, and, if this were not so, it would undoubtedly be deprived of half its attraction. But it must be remembered that success in removing Ferns from their habitats during the summer, more especially during the prevalence of hot weather, will more depend upon the method which

is adopted and upon the care which is exercised during the operation than will be the case during the winter or early spring. If, however, necessary precautions are adopted, Ferns may, as we have said, be freely taken up *at any time.*

Where a Fern-collecting tour is decided on, the collector should be provided with a small garden fork, a stout chisel, a hammer, a strong clasped knife, a trowel, and a covered basket—made either of rush or wicker—or other receptacle for carrying the Ferns. Should it be determined to hunt for very large specimens, it would be necessary to add a spade to the implements named. But in such a case special means of conveyance would need to be provided from some point, as near as possible to the locality from which the Ferns are to be taken; and indeed such conveyance would be desirable whenever Fern hunting on a large scale is to be indulged in. In an ordinary way, however, it will be found that the implements—such as a trowel, chisel, and hammer, &c.,—needed for removing from their habitats the smaller and rarer of, for instance, our native Ferns, could be conveniently carried in a small tourist's bag, slung on the back of the pedestrian collector, and in the same convenient way it would be found possible by careful packing to carry a good number of plants. Whenever possible it is desirable to take up the specimens with sufficient earth to prevent a disturbance of the roots. But in any case it is necessary that every possible portion of root should be taken up, even to the ultimate fibrous rootlets; and this object can be secured by carefully digging at a safe distance round and underneath the rootstock of the plant. Nothing so

much promotes the rapid recovery of a plant after removal as the exercise of great care in getting up the entire mass of roots and rootlets. It must be remembered that it has often taken the rootstock a long time to develop its network of rootlets, which as they grew have penetrated into all the surrounding interstices of the soil or rock from which the plant derives its sustenance. If, therefore, the work of months is ruthlessly undone in a moment by the thoughtless tearing up of the plant without its mass of root-feeders, it cannot be expected that the same vigour will be immediately shown under cultivation as was before exhibited. Yet many Fern collectors on getting out of the earth or rock by a sharp pull of the hand what looks to them like an entire root, are surprised and disappointed on finding that the earliest fronds thrown up under cultivation have sadly dwindled from their natural size. Even when to all appearance there is a sufficient mass of rootlets secured, it often happens that a considerable number are left unperceived in the earth.

Here in fact, as in everything else connected with the study of Ferns, it is Nature which should be closely copied, and if violence be done to Nature, success in cultivation cannot be expected.

It is especially in the removal of the rock-loving Ferns, that the greatest violence is usually done to the plants. Most of the rock-growing species have very abundant, wiry, fibrous rootlets, which penetrate in a very remarkable way the stony interstices in the neighbourhood of the rootstock. It is often made a subject of complaint by Fern collectors, that the rock-growing species are more difficult than any others to establish under cultivation.

But the difficulty arises chiefly from the circumstance which has already been alluded to. No doubt it is often a matter of difficulty to uproot the rock-loving Ferns, and it is for this work that a hammer and chisel are necessary, so that by the careful undermining and removal of the adjacent portions of rock, the crown, root-stock, and rootlets of the specimen desired may be got out unharmed. A little practice, however, if it be joined to a careful and loving study of the plant's peculiarities, will soon give the mastery in this kind of work.

Where by the careful process recommended Ferns are got out from their places of growth, damp moss or other moist material should be wrapped securely round their rootstocks and rootlets. In this way they can be conveniently carried to a considerable distance without any covering to the fronds, although if the air be very hot, dry, and sultry, the fronds, if intended to remain on the plant, must—especially those of the most fragile or herbaceous kinds—be kept under shelter, as they would be if put into a covered basket or other convenient covered receptacle. In removing the larger kinds of Ferns, however, during the summer, it may often be found convenient—especially where room for putting the specimens has to be economized—to cut off all, or at least the largest of the fronds, and to wrap in moss, or keep covered merely the root-stocks and rootlets. When planted in the garden or other place of cultivation, new fronds, as we have already said, will if under favourable conditions speedily be thrown up to supply the place of those removed. Where a tour is made in search of small specimens of Ferns, it is best, after wrapping moss

—which is generally to be found in the neighbourhood of Ferns—around each little root, to pack together—root side by side with root—the whole of the specimens. If a moist wrapper be then placed round them, they will keep fresh for days and even for weeks if occasionally looked at and sprinkled with water. If a quantity of reed straw be taken with the collector on a Fern-hunting excursion, it will be possible to preserve the fronds of the larger species by putting the reeds on the ground in a line with the direction of the fronds, and rolling them round the mass of roots and tying them in that position. In this way the tops of the reeds standing out around the fronds will protect them from injury until they are safely disposed of in the garden at home. In many instances reeds may be found for this purpose near the places where the Ferns are growing. In collecting the rock-loving species of Ferns, it is desirable when possible to detach a little portion of the rock, so as to avoid tearing off the rootlets of the plant.

One important object in Fern collecting should always be kept in mind. Before removing a plant from its home, the soil in which it is growing, its position as to shade or shelter, and the manner in which it has fastened itself to sloping bank, to tree fork, or to rifted rock, should be carefully noted; and the cultivator should then endeavour as nearly as possible to provide similar conditions of growth under cultivation. In this way many curious and beautiful lessons will be learned from the teachings of Nature.

CHAPTER XII.

FROND GATHERING.

In the compass of a small folio may be contained the delightful reminiscences of many a country ramble, the history, in short, written in colours from Nature's own pallet, of a holiday lifetime. Who would not hold such a record in his possession if he might? And all may do so. The means are at hand, and the way is plain and easily to be followed.

Frond gathering is essentially a summer pursuit. The proper season for it is, indeed, when Ferns are in the height of their glory, when they have reached to the perfection of their graceful form, are clothed with their richest of beautiful tints, and are mellow with a wealth of fruit. But we must describe in detail the process of gathering and preserving the feathery trophies of the stream-bank and ferny lane. Search should be made for

the most perfect specimens of the fronds it is intended to preserve, and such a search will require great care and attention. If there be a broken stipes, rachis, or pinnule; if there be any unnatural discoloration of the frond or injury by insects, such a specimen must be rejected. It is essential, too, that a frond to be gathered for preservation should be completely unrolled, so that every pinna, pinnule, and lobe should be unfolded into its most perfect state of growth. When possible, the time for taking the frond should be just before the final ripening of the fructification. If the latter be fully ripe the spore cases will burst in the process of drying, and will not be so interesting as objects of study when transferred to the folio after preservation. As there are varying periods of the year for the arriving at maturity of the fructification of different Ferns, it would not of course be possible in one tour extending over a limited space to gather all at the same stage. But by collecting throughout the summer and autumn during successive years, whenever the opportunity occurs, a complete collection of fronds, secured at the right season of growth, could be obtained. But as objects of beauty to the collector fronds grown to their full size, with or without their fructification, will always be an acquisition to the Fern portfolio.

And now as to the manner of collecting and preserving fronds, and the aids to be employed in the process. First of all it must be borne in mind that the object of the collector is to preserve the colour and entire form of the frond in a dry state. On starting, therefore, on a frond-gathering expedition it is necessary to go provided with a quantity of thick absorbent paper in large single

sheets. The best for the purpose is botanical drying paper, of which there are several kinds manufactured. The object of its preparation is to exclude any chemical substances which may act injuriously on the colouring of the fronds. The supply of this paper to be taken on a collecting tour must depend on the number of fronds to be secured. It will be desirable, however, not to attempt to get too many at one time. Fifty single sheets, of about eighteen inches long by twelve wide, will perhaps be as many as can be conveniently carried. The size mentioned is suggested as sufficiently large to include average-sized specimens of most of our native Ferns. For the larger kinds a larger-sized paper can be used, although for convenience in carrying and in arranging in the portfolio or herbarium it will be better to take portions only of large fronds. The sheets of botanical paper should all be cut to one size and secured between a couple of boards of the same size. Two strong leather buckle-straps to keep boards and paper compactly together will be necessary, and a third strap passed under the other two at the edges of the boards and buckled will answer the purpose of a handle by which to carry this temporary press and collecting case in one.

When the first frond is taken the boards must be opened and one of them laid flat on the ground and covered by a couple of sheets of the paper. On this the frond should be laid after being cut from the root-stock at the base of the stipes. Upon it should be placed the remainder of the sheets, beginning at the apex of the frond, holding the superincumbent sheets in the left

hand, the left wrist keeping them down whilst the right hand—as the whole length of the sheet is being lowered—is employed, with the aid of a small stiff brush or pointed stick, in adjusting the pinnæ and pinnules of the frond in a manner to prevent any crumpling, doubling down, or bending under of their parts. So soon as the entire frond has been satisfactorily laid out, the second board should be put upon the pile and the straps secured, though not too tightly, in case there should have been any accidental doubling under of pinna or pinnule. As other fronds are successively secured, the same process must be gone over again, care being taken in undoing the boards not to disturb the fronds already secured, and to allow at least two sheets of paper between each specimen. So soon as the collecting boards are full, the next proceeding is to arrange the fronds at home for the first stage of pressing. They should accordingly, as they are taken from the case, be carefully examined in order to remedy any little disarrangement of their parts. This can easily be done whilst the latter are green and pliant by the aid of the brush or pointed stick already recommended. A small magnifying glass held in the left hand will be found a useful aid in this work of properly arranging the fronds, especially of the smaller kinds of ferns, the disarrangement in the parts of which cannot sometimes be readily seen by the unaided eye.

A fresh set of drying sheets should now be used, the fronds laid carefully upon them—two or three sheets of paper between each—and the whole—enclosed in the boards—put under moderate pressure in a copying or other press, or in a press extemporized by using two

smooth but thick and heavy boards and some heavy weights. At the end of a short period—say the next day—the fronds should again be removed, placed once more, after rectifying any accidental disarrangement of parts, between fresh sheets of paper—the old sheets as disused being dried for subsequent use—and put into the press for another day. This process should be continued a few times until the fronds are thoroughly dry. The period will depend upon the kind of fronds, and their more or less succulent or herbaceous character. On a journey where a press cannot be easily extemporized, a substitute can be provided beforehand in the shape of a couple of very thick and heavy boards of oak or elm, with crosspieces, dovetailed at each end to keep them from warping, and very thick and strong leather buckle straps.

From the press the transfer to the portfolio is an easy process. And here arrangement must be left in a great measure to the taste of the collector. A few suggestions may, however, be of service. When Ferns have two kinds of fronds—barren and fruitful—specimens of each should be obtained, and it is desirable to have two specimens of the fronds of every species, so that front and back may be shown side by side, the front being generally distinguished by greater depth and richness of colouring, whilst the back has its arrangement of spore-cases and their coverings. The order of arranging the fronds should be according to genera, and in a portfolio provided with guards, and containing stout sheets of white paper. The specimens should be lightly fastened to the paper by means of threads passing over the stipes

or rachis, and secured at the back of the sheet. In this way they may be preserved for years, and the collection will become doubly an object of interest if to each specimen is attached a label bearing not only its name, but the place where it was gathered, together with the date of gathering.

Often in turning over the leaves of such a collection will sweet odours be exhaled, like the scent of new-mown hay or the breath of a country lane.

CHAPTER XIII.

ABOUT SOIL FOR FERNS.

WHERE and how can the Fern-lover obtain the soil suitable for growing his favourite plants? This is a question that the amateur Fern-cultivator will often ask, and though it would be easy to suggest that all trouble on this head may be saved by sending an order for Fern-soil to the nearest nurseryman or florist, such a reply would scarcely be deemed satisfactory, and the advice embodied in it, if followed, would not invariably lead to satisfactory results. When the agent employed to supply Fern-soil has given especial attention to Fern-culture, he may probably, in most cases, be trusted to provide what is requisite; but knowledge of and intelligent interest in the subject are not always to be expected even from professed gardeners, and the readers of this volume will at any rate wish to have such foreknowledge as may

help them to judge for themselves of the suitability or unsuitability of proffered soils.

Fern-soils may be said, generally, to be of three kinds, consisting of leaf-mould, peat, and loam; and most of our old woods and forests will be found to furnish all three, oftentimes lying in regular gradation one over the other. Leaf-mould is a vegetable soil, consisting, as its name indicates, of decayed leaves. Naturally this soil—in places that have remained for a long series of years undisturbed—will be found on the surface of the ground, having been there formed by the accumulation and decay of the leaves which annually fall from the trees. Immediately underlying the leaf-mould, peat—also a vegetable soil, but one consisting largely of root and other vegetable fibres—will often be found, though it is more particularly boggy and marshy ground that furnishes peat. Lower still we may come upon a stratum of what is called loam—a sort of clayey earth, existing under varying circumstances in varying degrees of lightness or heaviness.

Those who may wish to learn the secret of the luxuriance of Ferns in a forest, would do well to study the exact position as regards soil which these plants occupy, and to compare their varying degrees of prosperity with the varying circumstances of their growth. If this be done, it will invariably be found that the lower sides of the Ferns are embedded in peat or loam, or a mixture of the two, whilst the upper parts are surrounded by deposits of leaf-mould. The first-mentioned soils chiefly furnish the moisture required by the roots and rootlets; the leaf-mould supplies the chief part of the nutriment.

It may happen, however, that access to a wood or forest is not easily secured, and that the rough soil of the garden—with such sandy loam as can be easily obtained from a nurseryman for rendering light and friable the fern-compost—is all that can be made readily available. Under these circumstances a chemical fertilizer—such, for instance, as 'Amies' chemical manure'—will furnish a desirable substitute for the fertilizing properties of leaf-mould.

If, however, the opportunity should offer, the Fern-lover who desires to unravel the secret of successful Fern-growth should examine for himself the constituents of the soil in those places where Ferns are found growing in greatest luxuriance. In this way Nature herself will teach many useful and valuable lessons, which will greatly aid in the loving work of Fern-culture.

1. Forked Spleenwort.—2. Alternate Spleenwort.—3. Rue-leaved Spleenwort.—4. Black Maidenhair Spleenwort.—5. Lanceolate Spleenwort.—6. Rock Spleenwort.—7. Green Spleenwort.—8. Common Maidenhair Spleenwort.—9. Sea Spleenwort.—10. Scaly Spleenwort.

CHAPTER XIV.

THE SPLEENWORTS.

(See Plate, Page 111.)

The Spleenworts form a charming group, many of them being very small. But all are evergreen. They all delight to grow in rocky or stony crevices, sometimes—on walls—disporting themselves in the sunshine, but always preferring shade and moisture for their fibrous rootlets. The little waving tufts of the smaller species conspicuously ornament the rocks or walls on which they grow, whilst the larger kinds wear their beautiful fronds with a nobler grace. The common or popular name was given to this group of Ferns on account of an ancient belief in their power, when used as medicine, of curing splenetic affections. The genus *Asplenium* includes;—

1. The Forked Spleenwort (*Asplenium septentrionale*). 2. The Alternate Spleenwort (*Asplenium germanicum*). 3. The Rue-leaved Spleenwort (*Asplenium ruta muraria*). 4. The Black Maiden-hair Spleenwort (*Asplenium adiantum nigrum*). 5. The Lanceolate Spleenwort (*Asplenium lanceolatum*). 6. The Rock Spleenwort (*Asplenium fontanum*). 7. The Green Spleenwort (*Asplenium viride*). 8. The Common Maidenhair Spleenwort (*Asplenium trichomanes*). 9. The Sea Spleenwort (*Asplenium marinum*): and 10. The Scaly Spleenwort (*Asplenium ceterach*).

1.

THE FORKED SPLEENWORT.

Asplenium septentrionale.

FIG. 1, PAGE 111.

THE Forked Spleenwort is one of our rarest Ferns. It grows to an average height of two or three inches only, seldom exceeding six. Frond and stem are almost blended, the leafy part of the frond being merged into the stem by means of a sort of narrow leafy wing. The fronds, which are thrown up in little tufts around the crown of the plant, are divided into sometimes two and sometimes three forked divisions, somewhat club-shaped, narrow at their base, and broadening upwards, where, being widest, they are each finely jagged or slightly forked, the tips of the segments presenting sharp points. On the backs of the short fronds grow the spore-cases, which, when quite ripe, become confluent, forming one mass.

When growing wild on rocks the Forked Spleenwort

becomes densely tufted, and spreads into a mass of crowns, which throw up a little forest of fronds. In cultivating this Fern, sandy peat, leaf-mould, and old fragments of mortar should constitute the soil. With this should be interspersed pieces of freestone or sandstone, and the roots should be planted between fragments of stone so as to imitate, as nearly as possible, the conditions under which it is found growing on its native rocks.

2.

THE ALTERNATE SPLEENWORT.

Asplenium germanicum.

FIG. 2, PAGE 111.

A RARE and tiny Fern is the Alternate Spleenwort; even rarer than the one last described. Like the Spleenworts in general, it grows in rocky clefts, but has only been found in a few localities in England, Wales, and Scotland. It does not grow in Ireland. From the crown of its tufted root-stock spring up a mass of little fronds, which seldom grow to a height of more than six inches, though usually they are not so long. The leafy portion of the frond consists of a mid-stem or rachis, on each side of which, placed alternately, are a number of wedge-shaped leaflets, connected with the rachis at their narrowest part, and being consequently broadest at their tops. The tops are irregularly cleft or toothed, presenting a series of sharp points. The frond usually ends in a leaflet larger than those which are placed alternately along the rachis; but this final leaflet is, like the others, sharply notched or toothed.

The same method of cultivation recommended for the Forked Spleenwort will suit its near relative *Asplenium germanicum*, namely, sandy peat and leaf-mould for soil, and an arrangement of little pieces of sandstone or freestone in the pot, or in the cleft of the rockery where it is grown.

3.

THE RUE-LEAVED SPLEENWORT.

Asplenium ruta-muraria.

Fig. 3, Page 111.

Of all our native Ferns the Rue-leaved Spleenwort or Wall Rue is, perhaps, the most unpretending in appearance. Yet it is a most interesting little Fern, and will well repay study and care. It is very diminutive, sometimes only growing to a height of about one inch, but when under very favourable conditions, in a wild state, it will reach a length of several inches. It is widely distributed, loving to fasten itself on old walls, rocks, or the sides of bridges of all kinds, spanning water. Often it is found growing on church walls and the walls of dwelling houses. It is, indeed, a familiar little Fern, and is frequently seen flourishing in the midst of towns, seeming, indeed, to love the society of man. But the secret of its preference for buildings of various kinds is its fondness for old mortar. When growing on walls the finest specimens are always those which are found at the top of the walls, just beneath the coping stone or crowning bricks, which serve as a protection for the crown of the Wall Rue. Between the bricks of walls and in the crevices of

rocks the little Fern inserts its wiry fibrous rootlets, which suck in the moisture pent by the stony covering, and revel in the combination of old mortar and deposits of leaf-mould formed by dropping leaves. The Wall Rue prefers to grow—root-stock, crown, and rootlets,—horizontally, a position rendered necessary by the habit of the little plant in growing between the mortar lines of walls. From its tufted crown the tiny fronds shoot out in dense clusters. Stem and leafy part are usually about equal in length. The tiny branches of the frond are placed alternately on each side of the rachis, each branch being again divided into little diamond-shaped lobes. These lobes are thick and leathery in texture and of a dark, shining green colour. When the spores ripen the clusters of spore-cases usually become confluent, so that in the autumn the backs of the leaflets are thickly covered with rich brown masses of seed. Evergreen in habit, the fronds of this little Fern endure through the winter.

Some difficulty is experienced by amateur Fern growers in the cultivation of the Wall Rue, a difficulty which, it is to be feared, arises chiefly from want of care in sufficiently studying the natural conditions under which it thrives. Too frequently the Fern is not properly transplanted. Perhaps only a third of its little fibrous rootlets are secured when it is taken from its natural habitat. In such a case failure in growing it is almost inevitable. It is often very difficult to transplant it without doing injury to crown or root-stock, and, indeed, it is generally impossible to obtain it entire and uninjured without removing the stones amongst which it is growing. But

this difficulty overcome, and the tiny plant secured intact, it will be generally found comparatively easy of cultivation. It should be planted between fragments of stone in such a manner as to imitate, as nearly as possible, its natural conditions; and for soil it must have sandy leaf-mould and old pieces of mortar.

4.

THE BLACK MAIDENHAIR SPLEENWORT.

Asplenium adiantum-nigrum.

Fig. 4, Page 111.

The Black Maidenhair is, perhaps, the most elegant of the Spleenworts, chiefly on account of the elaborate and beautiful manner in which its fronds are divided. It grows from a very tufted root-stock, and throws up thick clusters of fronds, which vary considerably in height. Sometimes, when growing on walls in somewhat dry and exposed situations, it may be found no more than an inch or at most two or three inches high. But when it is in situations more congenial to it, and under conditions such as will be presently described, it attains a height of from eighteen inches to two feet, and possesses extreme elegance. The young fronds and their stems are, when first starting from the root-stock, ordinarily light-green in colour. But, as they attain maturity, they become—the latter a dark rich purple, and the former—the leafy part—a dark shining green. In luxuriant specimens the stem of the frond is as long as—often longer than—its other part. But in small

specimens found growing on walls the stem is usually much shorter than the rest of the frond. The latter, in its leafy part, is triangular in shape; and alternately placed on opposite sides of its rachis or mid-rib are a number of triangular-shaped branches, gradually, however, as they diminish in size and length towards the point of the frond, becoming less and less distinctly triangular, until the branches near the extreme point of the top are mere leaflets, bluntly club-shaped and indented, and finally merging in the tip of the frond. The lowest branches on each side of the frond, being distinctly triangular, are again divided into triangular-shaped leaflets, which follow the same arrangement towards the point of the branch, as the branches follow, as already described, towards the point of the frond. The triangular-shaped leaflets at the base of the lower branches of the frond are, in luxuriant specimens of the Black Maidenhair Spleenwort, again divided into lobes—at their lower extremity these ultimate divisions being beautifully notched or serrated. Depending on the situation in which it grows, the fronds of the Black Maidenhair Spleenwort are either very thick, rigid, and leathery in texture, or of a softer and more drooping habit. The plant is very decidedly evergreen, its fronds, springing up in May or June, continuing to grow until September or October, and from that time, when it has reached its maturity, lasting until the ensuing spring. When in its perfectly mature state, in the autumn, the spores, which have clustered at the back of its fronds, become confluent and densely cover the whole under surface of the leaflets. Being then of a rich dark brown

colour, they finely contrast with the dark shining green of the plant, and strikingly add to its handsome appearance.

The Black Maidenhair Spleenwort is widely distributed over the United Kingdom. It occurs plentifully on walls, old ruins, and river bridges, growing, like the Wall Rue, in the interstices between the stones. It also grows on old stony hedge-banks, and it is in such situations, when favoured by a rich soil of leaf-mould which may have collected in the crevices formed by the loosely arranged stones, and when sheltered by overhanging bushes, that it attains its most luxuriant growth. We have often found it growing on the soft soil of the hedge-bank. But as it is an essentially rock-loving Fern, it loves best to grow on such hedge-banks as we have described.

Asplenium adiantum-nigrum is a beautiful Fern for the rockery, but must be planted in a shady, sheltered corner amongst stones, in a soil composed of rich sandy loam and leaf-mould. It will grow readily in pots, but must be planted amongst the stones in which it delights.

5.

THE LANCEOLATE SPLEENWORT.

Asplenium lanceolatum.

FIG. 5, PAGE 111.

THERE is so much similarity between the Lanceolate and the Black Maidenhair Spleenwort, that Fern-hunters are in danger oftentimes of mistaking the one for the other. But there is one mark by which the two Ferns can be unmistakably distinguished from each other. In the Black Maidenhair the frond is broadest at its base, and

tapers upwards gradually to its point; it is, in fact, distinctly triangular. In *Lanceolatum*, on the contrary, the frond is broadest about the centre of its leafy part; and from thence it tapers in both directions to its tip and to its base. In other respects the description of the fronds of *Adiantum nigrum* will very nearly apply to those of *Lanceolatum*, with this general difference, that the widest branches of the fronds of *Lanceolatum* are not so broad and not so much divided as the widest branches of the fronds of *Adiantum-nigrum*, which are, as already stated, the lowest branches in the frond. Another mark of recognition in *Lanceolatum* is the peculiar arrangement of the cases containing the ripened spores. In *Adiantum-nigrum* these are at first arranged in lines at the backs of the fronds; then they become confluent, and often densely crowd the entire under surface of the leaflets. In *Lanceolatum* they are ordinarily arranged in little round bulged clusters, which are distinct from each other.

The Black Maidenhair Spleenwort is widely distributed throughout the United Kingdom. But *Lanceolatum* is much rarer, and is confined in its range to the south and west of England, to South Wales, to the south of Ireland, and to the Channel Islands. In the Channel Islands it grows very luxuriantly. It varies in size, from tiny plants of some six inches in length to luxuriant specimens of a foot and eighteen inches long. Another peculiarity of *Lanceolatum* is that it prefers the sea-coast, and is often found on rocks in company with the Sea Spleenwort. In the same company it is also often found growing luxuriantly in dripping sea-caves.

In the open-air fernery the Lanceolate Spleenwort requires peculiar care. It does not appear to habituate itself so readily to artificial conditions of existence as the Black Maidenhair; oftentimes, doubtless, the fault may lie with the Fern-hunter, who perhaps has not used sufficient care in removing *Lanceolatum* from its native habitats. It often grows so firmly imbedded in rocky clefts that its eradication in an uninjured state is a matter of difficulty. But when this is properly accomplished, and the plant is secured with its crown uninjured, and its fibrous rootlets entire, careful cultivation will be rewarded by success. If planted in the open rockery, or indoors in pots, the soil should be composed of silver-sand, or light sandy loam and leaf-mould, mixed together in about equal proportions; and to this compost should be added some small pieces of sandstone.

Under a covering of glass, however, *Lanceolatum* is thoroughly at home; for such a method of cultivation appears more nearly to supply the natural conditions under which this beautiful Fern grows in greatest luxuriance. We have devoted one little *terra-cotta* stand and shade to three fine specimens of *Lanceolatum*, which we obtained from the vicinity of the Logan Stone, that crowns the heights of Lustleigh Cleave, on Dartmoor. We planted the roots, and gently wedged in the crowns of the plants between little blocks of sandstone, keeping them carefully under their glass covering, which is only removed from time to time to give air and water. They are thriving admirably, and are throwing up new fronds most vigorously. They delight in the shady situation in which they are placed, and revel in the perpetual

moisture that surrounds their beautiful fronds, and distils on them like dewdrops.

6.

THE ROCK SPLEENWORT.

Asplenium fontanum.

FIG. 6, PAGE 111.

ONE of the most rare of our rarer species of British Ferns is the Rock Spleenwort; so rare, indeed, that some doubts as to its actual identity with the supposed specimens of it discovered in these islands have been raised. But these doubts will probably be dispelled by the evidence which has been produced as to the discovery of this species—evidence making it pretty clear that its inclusion amongst British plants can be justified. In two or three places in England, in one locality in Wales, in one in Scotland, and in one in Ireland, *Asplenium fontanum* has—according to tolerably trustworthy authority—been found. It grows amidst sheltered inland rocks and in sea caves, and possibly may not be so rare as is generally supposed, though certainly—if it be more plentiful than Fern collectors believe, its abundance has remained, as yet, the secret of some, probably, inaccessible localities.

The present species might somewhat appropriately be likened in a general way to small specimens of *Asplenium lanceolatum*. The fronds are of an average length of some four or five inches, bright green in colour, and thick in texture. They have short, dark, purplish stems, their leafy portions being narrowly lance-shaped, tapering to their bases as well as to their apices. The tiny

branches of the frond are placed in alternation along on each side of the rachis, and are furnished with alternately-placed triangular or four-sided lobes, which are deeply and sharply incised, the incisions giving a beautifully serrated appearance to the lobes.

Under green-house cultivation the fronds of this beautiful little Fern will sometimes attain a length of twelve inches. The soil for growing it should be sandy loam and leaf-mould; and small pieces of soft, broken stone should be mixed with the compost, the root-stock of *Fontanum* being placed between little blocks of the stone. It is a charming little plant, having one of the freshest and most delightful of the hues of fresh and delightful green.

7.

THE GREEN SPLEENWORT.

Asplenium viride.

FIG. 7, PAGE 111.

A FERN of the rocky moorland and the mountain stream; not rare, but local in its distribution. It grows in the moist interstices which lie between the stony masses. But it mostly loves a rocky home in immediate contiguity to the soft vapour of the wild cascade. It delights to grow in the tiny trickle caused by percolating water. Little wiry fibrous rootlets, that plunge within the hearts of rocks in search of the soft veins of leaf-mould; a black, tufted root-stock, from which start the lovely fronds; a short stipes, purple at its base, but beyond of a vivid and delightful green; a rachis of the same delightful green, and on each side of it, placed in alternation, a row of

little, egg-shaped, saw-edged leaflets, diminishing in size as the frond tapers to a point. Each root-stock produces these pretty little fronds in thick clusters, so that a luxuriant specimen of the plant presents a delightfully fresh appearance. The fronds grow to various heights, their luxuriance depending on the favourable or unfavourable nature of the situation in which the plant grows. Sometimes they are not more than an inch or two in height; sometimes they are five or six, occasionally as much as eight or ten.

Delighting as it does in an atmosphere of moisture, it should be planted where it can secure the conditions which it requires. It may be grown in the rockery or in pots in the house. But under a covering of glass it will thrive admirably, for there it can most easily secure the moisture which it loves.

8.

THE COMMON MAIDENHAIR SPLEENWORT.

Asplenium trichomanes.

FIG. 8, PAGE 111.

THIS Fern and the Green Spleenwort are very nearly related indeed; the great distinction being that *Viride*, as its name seems to imply, has nearly the whole of its stipes and the whole of its rachis of a bright green, whilst *Trichomanes*, when mature, has both the stipes and rachis on its fronds of a dark, shining, purple colour, approaching to black. The Common Maidenhair Spleenwort is, too, as its name indicates, far more plentiful, and far more widely distributed throughout the United Kingdom, than

its half-sister *Viride*. It is, too, hardier than the latter, and easier of cultivation. The same description, with the exceptions which have been pointed out, will apply in the case of both Ferns: black, tufted root-stocks; wiry, fibrous rootlets; thin, narrow fronds; brittle stems; and two rows of leaflets,—now placed opposite in pairs, and now ranged alternately—egg-shaped and saw-edged. Both grow from their crowns in dense clusters. But, as we have already inferred, *Trichomanes* is found growing in sunnier and more exposed situations than *Viride*. *Trichomanes*, nevertheless, though so hardy and bold, best loves deep shade and moisture. It never, however, grows on the ground, but must be elevated on wall, rock, or hedge-bank.

It is really difficult to imagine anything more beautiful than a wall or rock clothed with dense tufts of the fronds of *Trichomanes*, with their shining, purplish-black stems and refreshingly green leaflets. Peer over the arch of yonder bridge, beneath which the stream is surging and splashing! Beyond you, dark woods tower up against the horizon; beneath, the shining river reflects in its limpid surface the blue canopy of the sky checkered with fleecy white clouds. You follow the course of the current, watching some foam spot as it eddies along and disappears beneath the arch over which you are leaning. As you gaze intently into the stream, your cheeks are fanned by the brisk moorland breeze, which comes fresh laden with the sweet perfumes of wild flowers. But the breeze has stirred the tiny life which clings to the stony sides of the bridge; and your eyes are suddenly riveted by waving tufts of purple and green—a mimic forest of

Fern-fronds clothing the arches of stone and mortar. Examine the exquisite arrangements of these beautiful fronds,—green gems on stalks like maiden's hair. O bountiful Creator, to spread out such rich treasures as these! to make the dry, hard stones live with their charming dress of glorious green!

Thousands of sights like these may be seen in the wild, rocky moorlands, on bridges which span the moorland streams. But much as it loves the wild home of Nature, and the damp rock in the moorland valley, the beautiful fronds of the Common Maidenhair Spleenwort may be seen even in the heart of towns,—for it will grow on houses and garden walls. Though a rock-loving Fern, it will also oftentimes grow with great luxuriance on the soft soil of a sloping hedge-bank.

Asplenium trichomanes is evergreen and hardy, enduring bravely through the winter, and sturdily retaining its little bristling stalks, even when their crops of leaves have gone. It is a delightful occupant of the open-air rockery; but it will grow readily and well in pots. Put it in a high and shady cleft of your rockery—give it leaf-mould, and sand, and broken pieces of soft brick or stone—and it will always be refreshing and delightful.

9.

THE SEA SPLEENWORT.

Asplenium marinum.

FIG. 9, PAGE 111.

THE habitats of the Sea Spleenwort are sea rocks and dripping sea caves. The instances are very few indeed

in which it has been found growing away from the sea, and even in these rare instances the plants have been removed but a short distance from the direct influence of the sea air. The true habitat of the Sea Spleenwort is the open sea coast; sometimes on the outside face of the rocks, and sometimes within shadowy caverns. It not only grows in crevices in the rock, but on the rock itself, into which it insinuates its roots. Sometimes it grows on the roofs and at the sides of dripping caverns; and in such situations it will often spread its roots like a web over the damp, stony surfaces.

Its fronds are leathery in texture; and of so bright, fresh, and shining a green colour, that it is positively refreshing to look upon them. Average specimens are six or eight inches long; but in dripping sea caves they sometimes hang pendant from the roofs, and reach a length of as much as eighteen inches. The shape of the frond of the Sea Spleenwort is narrowly oblong, broadest about the centre, narrowing slightly towards the base, tapering upwards, and blunt-pointed. On each side of the rachis is a simple row of leaflets. These are arranged in pairs near the bottom of the frond, but become alternated towards the top. Immediately contiguous to, and on each side of the rachis, is a very narrow leafy wing or expansion, not readily discernible without close inspection, but serving in some sort to connect the several leaflets. These are somewhat irregularly egg-shaped, sometimes almost roughly four-sided, connected with the rachis at their lower side by means of a very short stalk, and slightly indented. The leaflets are merged in the tip of the frond.

We remember finding some specimens of the Sea Spleenwort down the Dart, about three or four miles from Totnes. We were looking for some small specimens of the Fern, which we were told grew in the locality; but we lighted by chance upon a small cluster of larger plants. The tide was out, and as we were searching the rocky banks of the river, we suddenly rounded a jutting rocky corner, and came on to a strand that would have been inaccessible at high tide. On our right the river bank shelved in, and formed a sort of overhanging projection, crowned with large shrubs, and sheltered by trees rising on the high ground above. On the soft red sandstone rock, and just above high-water level, we came upon a number of tufts of *Asplenium marinum*. It was a matter of considerable difficulty to get them out intact. The roots were positively imbedded in the solid rock; and it was only by dint of persevering labour with a chisel that we at length succeeded, by chipping away the surrounding rock, in getting out our plants entire. We carefully preserved our specimens; and we have them now, green and vigorous, in our glass case.

The Sea Spleenwort will rarely be found to grow, it is said, on the open rockery, away from the sea, as it needs the sea air. But in a glass case it will grow luxuriantly. It should be planted between fragments of rock—red sandstone if possible—in soil composed of sandy leaf-mould and peat. It loves warmth and excessive moisture; and in the house these conditions are supplied if it be kept under a covering of glass. We have adopted the plan of devoting a large ornamental Fern-pan to our specimens, filling up with the necessary soil upon a

layer of broken flower-pot and charcoal. On the top of the soil are large pieces of brick and stone, and between these our Ferns are planted. The whole is covered with a large bell glass; and under the same covering we have the Lanceolate Spleenwort and the True Maidenhair. It is, in fact, a miniature rockery which we have established under glass. Already the moisture has coated the bricks and stony surfaces with moss and seedling Ferns; and we take a keen delight from time to time in uncovering our miniature 'Fern Paradise' to get a brief glimpse of the shining Fern-fronds, tipped with the mimic dewdrops which distil upon them in their moist prison.

10.

THE SCALY SPLEENWORT.

Asplenium ceterach.

Fig. 10, Page 111.

For richness and variety of colouring, the Scale Fern is the handsomest of the Spleenworts. It is, indeed, an exquisite little plant. Like the rest of its family, it loves to grow on rocks and walls, even preferring the latter, and oftentimes growing abundantly within town limits, on barn and garden walls, and even on house walls. Average specimens are about three or four inches in length; but, under favourable conditions, they may attain a length of six, seven, eight, or more inches. They are believed to have an especial fondness for old mortar. Hence the reason why they are so frequently found on old walls.

The frond of the Scaly Spleenwort has a short stipes, scale-covered; and its upper portion consists of one elongated, deeply and widely scalloped leaf; or, perhaps, to make the explanation clearer, it would be desirable to liken the frond of the Scale Fern to a coarse, double-edged saw; but what would correspond to the teeth of the saw are blunt-pointed lobes. The frond is widest at its centre, and tapers at each end. It has a thick midrib or rachis. What constitutes the peculiar elegance of the Scale Fern is the contrast presented by the two sides of the frond. Its upper surface is of a rich bluish-green, soft and velvety to the touch; its under-surface is completely hidden by a thick drapery of densely-packed reddish-brown scales. These beautiful scales extend to every part of the back of the frond, covering up midrib and pinnule, and affording a snug hiding-place for the spore-cases. The fronds grow in tufts from a central crown, and are always most luxuriant when found at the top of walls, under the shelter of overhanging trees.

Well do we remember the pleasure we experienced on finding, after a long search, our first specimens of the Scale Fern. We had previously read the description of this beautiful species, and had seen the coloured representations of it; but had never happened to set eyes on the living plant, either in a wild or cultivated state. We, therefore, started in our first search for the wild plant from Totnes in the direction of Berry Pomeroy Castle,—having been assured that we should find some specimens on an old wall which skirted the wood surrounding the Castle. We were some time in finding the old wall in question; but we at length lighted upon it. Carefully

we searched on both sides for some distance, but without encountering anything at all like our descriptions of *Ceterach*. Presently, however, the boundary wall was cast into deeper shadow by the high and overlapping branches of the trees in the wood; and continuing our search along the inner side of the wall, we at length found several fine plants of the Scale Fern revelling in the old mortar and leaf-mould, in a deep shady cleft formed by the pointed coping-stones. There could be no mistaking the strongly-marked characteristics of *Ceterach* —the thick, green velvety texture of the frond on one side, and the dense carpeting of rich reddish-brown scales on the under surface.

The finest specimens of the beautiful Scale Fern which we have ever encountered, we found on the top of a very high wall which skirted another wood in the neighbourhood of Totnes. The large stones at the top of the wall had become loose with time, and the perpetual droppings of leaves during many years from the trees which overhung it, had accumulated a rich deposit of leaf-mould between the loosened stones. Immediately underneath the crowning stones we found the largest specimens of *Ceterach*, with fronds over seven inches long, and enormous roots extending to nearly the whole width of the wall, and forming a compact mass nearly a foot square. This wall, like the one at Berry Pomeroy, was immersed in the deepest shade flung by the overhanging trees.

Planted in the highest and shadiest clefts of the out-of-door rockery, with leaf-mould, sand, and old bits of mortar for soil; kept sufficiently moist, but not drenched with water, the elegant Scale Fern will succeed well.

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